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ABSTRACT

Collecting and maintaining a variety of animals for study is the challenge of this Unified Sciences and Mathematics for Elementary Schools (USMES) unit. The challenge is general enough to apply to many problem-solving situations in mathematics, science, social science, and language arts at any elementary school level (grades 1-8). The Teacher Resource Book for the unit is divided into five sections. Section I describes the USMES approach to student-initiated investigations of real problems, including a discussion of the nature of USMES "challenges." Section II provides an overview of possible student activities with comments on prerequisite skills, instructional strategies, suggestions when using the unit with primary grades, a flow chart illustrating how investigations evolve from students' discussions of problems, and a hypothetical account of intermediate-level class activities. Section III provides documented events of actual class activities from kindergarten and grades 1, 4, and 5. Section IV includes lists of "How To" cards and background papers, bibliography of non-USMES materials, and a glossary. Section V consists of charts identifying skills, concepts, processes, and areas of study learned as students become involved with the activities. (JN)

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USMES

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School Zoo

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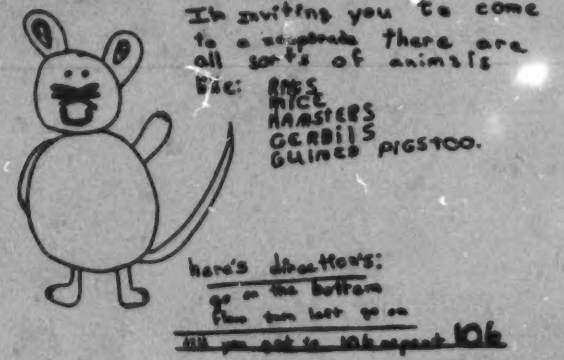
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Im inviting you to come to a zoo there are all sorts of animals like: RATS MICE HAMSTERS GERBILS GUINEA PIGS TOO.
here's directions:
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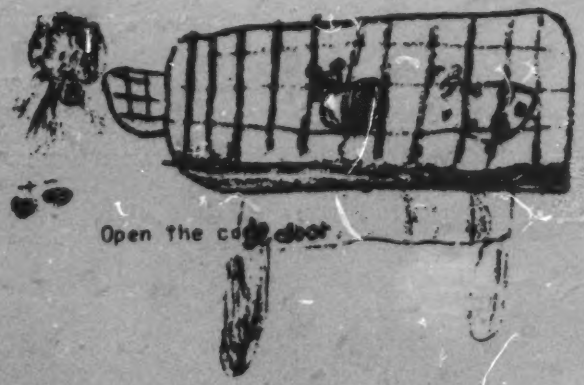
then turn left go on
till you get to 10th street 10th

APRIL 8th
COME ON IN!



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Teacher Resource Book

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UNIFIED SCIENCES AND MATHEMATICS FOR ELEMENTARY SCHOOLS:
Mathematics and the Natural, Social, and Communications Sciences in Real Problem Solving.

School Zoo

Third Edition

Education Development Center, Inc.
55 Chapel Street
Newton, MA 02160

Trial Edition

Complete USMES Library ISBN: 0-89292-033-5
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Education Development Center, Inc., Newton 02160

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CHALLENGE: COLLECT AND MAINTAIN A VARIETY OF ANIMALS TO HELP YOUR CLASS AND OTHERS LEARN ABOUT THEM.

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Preface

The USMES Project

Unified Sciences and Mathematics for Elementary Schools: Mathematics and the Natural, Social, and Communications Sciences in Real Problem Solving (USMES) was formed in response to the recommendations of the 1967 Cambridge Conference on the Correlation of Science and Mathematics in the Schools.* Since its inception in 1970, USMES has been funded by the National Science Foundation to develop and carry out field trials of interdisciplinary units centered on long-range investigations of real and practical problems (or "challenges") taken from the local school/community environment. School planners can use these units to design a flexible curriculum for grades kindergarten through eight in which real problem solving plays an important role.

Development and field trials were carried out by teachers and students in the classroom with the assistance of university specialists at workshops and at occasional other meetings. The work was coordinated by a staff at the Education Development Center in Newton, Massachusetts. In addition, the staff at EDC coordinated implementation programs involving schools, districts, and colleges that are carrying out local USMES implementation programs for teachers and schools in their area.

Trial editions of the following units are currently available:

- Advertising
- Bicycle Transportation
- Classroom Design
- Classroom Management
- Consumer Research
- Describing People
- Designing for Human Proportions
- Design Lab Design
- Eating in School
- Getting There
- Growing Plants
- Manufacturing
- Mass Communications
- Nature Trails
- Orientation
- Pedestrian Crossings
- Play Area Design and Use
- Protecting Property
- School Rules
- School Supplies
- School Zoo
- Soft Drink Design
- Traffic Flow
- Using Free Time
- Ways to Learn/Teach
- Weather Predictions

*See Goals for the Correlation of Elementary Science and Mathematics, Houghton Mifflin Co., Boston, 1969.

USMES Resources

In responding to a long-range challenge, the students and teachers often have need of a wide range of resources. In fact, all of the people and materials in the school and community are important resources for USMES activities. In addition USMES provides resources for both teachers and students. A complete set of all the written materials comprise the USMES library, which should be available in each school using USMES units. These materials include--

1. *The USMES Guide*: This book is a compilation of materials that may be used for long-range planning of a curriculum that incorporates the USMES program. It describes the USMES project, real problem solving, classroom strategies, the Design Lab, the units, and the support materials as well as ways that USMES helps students learn basic skills.

2. *Teacher Resource Books* (one for each challenge): Each of these guides to using USMES units describes a broad problem, explains how students might narrow that problem to fit their particular needs, recommends classroom strategies, presents edited logs from teachers whose classes have worked on the unit, and contains charts that indicate basic skills, processes, and areas of study that students may learn and utilize.

3. *Design Lab Manual*: This guide helps teachers and administrators set up, run, and use a Design Lab--a place with tools and materials in which the students can build things they need for their work on USMES. A Design Lab may be a corner of a classroom, a portable cart, or a separate room. Because many "hands-on" activities may take place in the classroom, every USMES teacher should have a Design Lab Manual.

4. *"How To" Series*: These student materials provide information to students about specific problems that may arise during USMES units. The regular *"How To" Series* covers problems in measuring, graphing, data handling, etc., and is available in two versions--a series of

cartoon-style booklets for primary grades and a series of magazine-style booklets with more reading matter for upper grades. The *Design Lab "How To" Series* is available in two illustrated card versions--one for primary grades and one for upper grades. A complete list of the *"How To" Series* can be found in the *USMES Guide*.

5. *Background Papers*: These papers, correlated with the *"How To" Series*, provide teachers with information and hints that do not appear in the student materials. A complete list can be found in the *USMES Guide*.

6. *Curriculum Correlation Guide*: By correlating the twenty-six USMES units with other curriculum materials, this book helps teachers to integrate USMES with other school activities and lessons.

The preceding materials are described in brief in the USMES brochure, which can be used by teachers and administrators to disseminate information about the program to the local community. A variety of other dissemination and implementation materials are also available for individuals and groups involved in local implementation programs. They include *Preparing People for USMES: An Implementation Resource Book*, the USMES slide/tape show, the Design Lab slide/tape show, the Design Lab brochure, videotapes of classroom activities, a general report on evaluation results, a map showing the locations of schools conducting local implementation of USMES, a list of experienced USMES teachers and university consultants, and newspaper and magazine articles.

* * * * *

Because Tri-Wall was the only readily available brand of three-layered cardboard at the time the project began, USMES has used it at workshops and in schools; consequently, references to Tri-Wall can be found throughout the Teacher Resource Books. The addresses of suppliers of three-layered cardboard can be found in the Design Lab Manual.

Introduction

Using the Teacher Resource Book

When teachers try a new curriculum for the first time, they need to understand the philosophy behind the curriculum. The USMES approach to student-initiated investigations of real problems is outlined in section A of this Teacher Resource Book.

Section B starts with a brief overview of possible student activities arising from the challenge; comments on prerequisite skills are included. Following that is a discussion of the classroom strategy for USMES real problem-solving activities, including introduction of the challenge, student activity, resources, and Design Lab use. Subsequent pages include a description of the use of the unit in primary grades, a flow chart and a composite log that indicate the range of possible student work, and a list of questions that the teacher may find useful for focusing the students' activities on the challenge.

Because students initiate all the activities in response to the challenge and because the work of one class may differ from that undertaken by other classes, teachers familiar with USMES need to read only sections A and B before introducing the challenge to students.

Section C of this book is the documentation section. These edited teachers' logs show the variety of ways in which students in different classes have worked at finding a solution to the challenge.

Section D contains a list of the titles of relevant sets of "How To" Cards and brief descriptions of the Background Papers pertaining to the unit. Also included in section D is a glossary of the terms used in the Teacher Resource Book and an annotated bibliography.

Section E contains charts that indicate the comparative strengths of the unit in terms of real problem solving, mathematics, science, social science, and language arts. It also contains a list of explicit examples of real problem solving and other subject area skills, processes, and areas of study learned and utilized in the unit. These charts and lists are based on documentation of activities that have taken place in USMES classes. Knowing ahead of time which basic skills and processes are likely to be utilized, teachers can postpone teaching that part of their regular program until later in the year. At that time students can study them in the usual way if they have not already learned them as part of their USMES activities.

A. Real Problem Solving and USMES

*If life were of such a constant nature that there were only a few chores to do and they were done over and over in exactly the same way, the case for knowing how to solve problems would not be so compelling. All one would have to do would be to learn how to do the few jobs at the outset. From then on he could rely on memory and habit. Fortunately--or unfortunately depending upon one's point of view--life is not simple and unchanging. Rather it is changing so rapidly that about all we can predict is that things will be different in the future. In such a world the ability to adjust and to solve one's problems is of paramount importance.**

Real Problem Solving

USMES is based on the beliefs that real problem solving is an important skill to be learned and that many math, science, social science, and language arts skills may be learned more quickly and easily within the context of student investigations of real problems. Real problem solving, as exemplified by USMES, implies a style of education which involves students in investigating and solving real problems. It provides the bridge between the abstractions of the school curriculum and the world of the student. Each USMES unit presents a problem in the form of a challenge that is interesting to children because it is both real and practical. The problem is real in several respects: (1) the problem applies to some aspect of student life in the school or community, (2) a solution is needed and not presently known, at least for the particular case in question, (3) the students must consider the entire situation with all the accompanying variables and complexities, and (4) the problem is such that the work done by the students can lead to some improvement in the situation. This expectation of useful accomplishment provides the motivation for children to carry out the comprehensive investigations needed to find some solution to the challenge.

The level at which the children approach the problems, the investigations that they carry out, and the solutions

*Kenneth B. Henderson and Robert E. Pingry, "Problem-Solving in Mathematics," in *The Learning of Mathematics: Its Theory and Practice,* Twenty-first Yearbook of the National Council of Teachers of Mathematics (Washington, D.C.: The Council, 1953), p. 233.

that they devise may vary according to the age and ability of the children. However, real problem solving involves them, at some level, in all aspects of the problem-solving process: definition of the problem; determination of the important factors in the problem; observation; measurement; collection of data; analysis of the data using graphs, charts, statistics, or whatever means the students can find; discussion; formulation and trial of suggested solutions; clarification of values; decision making; and communications of findings to others. In addition, students become more inquisitive, more cooperative in working with others, more critical in their thinking, more self-reliant, and more interested in helping to improve social conditions.

The USMES Approach

To learn the process of real problem solving, the students must encounter, formulate, and find some solution to complete and realistic problems. The students themselves, not the teacher, must analyze the problem, choose the variables that should be investigated, search out the facts, and judge the correctness of their hypotheses and conclusions. In real problem-solving activities, the teacher acts as a coordinator and collaborator, not an authoritative answer-giver.

The problem is first reworded by students in specific terms that apply to their school or community, and the various aspects of the problem are discussed by the class. The students then suggest approaches to the problem and set priorities for the investigations they plan to carry out. A typical USMES class consists of several groups working on different aspects of the problem. As the groups report periodically to the class on their progress, new directions are identified and new task forces are formed as needed. Thus, work on an USMES challenge provides students with a "discovery-learning" or "action-oriented" experience.

Real problem solving does not rely solely on the discovery-learning concept. In the real world people have access to certain facts and techniques when they recognize the need for them. The same should be true in the classroom. When the students find that certain facts and skills are necessary for continuing their investigation, they learn willingly and quickly in a more directed way to acquire these facts and skills. Consequently, the students should have available different resources that they may use as they recognize the need for them, but they should still be left with a wide scope to explore their own ideas and methods.

Certain information on specific skills is provided by the sets of USMES "How To" Cards. The students are referred only to the set for which they have clearly identified a need and only when they are unable to proceed on their own. Each "How To" Cards title clearly indicates the skill involved--"How to Use a Stopwatch," "How to Make a Bar Graph Picture of Your Data," etc. (A complete list of the "How To" Cards can be found in Chapter IX of the USMES Guide.)

Another resource provided by USMES is the Design Lab or its classroom equivalent. The Design Lab provides a central location for tools and materials where devices may be constructed and tested without appreciably disrupting other classroom activities. Ideally, it is a separate room with space for all necessary supplies and equipment and work space for the children. However, it may be as small as a corner of the classroom and may contain only a few tools and supplies. Since the benefits of real problem solving can be obtained by the students only if they have a means to follow up their ideas, the availability of a Design Lab can be a very important asset.

Optimally, the operation of the school's Design Lab should be such as to make it available to the students whenever they need it. It should be as free as possible from set scheduling or programming. The students use the Design Lab to try out their own ideas and/or to design, construct, test, and improve many devices initiated by their responses to the USMES challenges. While this optimum operation of the Design Lab may not always be possible due to various limitations, "hands-on" activities may take place in the classroom even though a Design Lab may not be available. (A detailed discussion of the Design Lab can be found in Chapter VI of the USMES Guide, while a complete list of "How To" Cards covering such Design Lab skills as sawing, gluing, nailing, soldering, is contained in Chapter IX.)

Work on all USMES challenges is not only sufficiently complex to require the collaboration of the whole class but also diverse enough to enable each student to contribute according to his/her interest and ability. However, it should be noted that if fewer than ten to twelve students from the class are carrying out the investigation of a unit challenge, the extent of their discovery and learning can be expected to be less than if more members of the class are involved. While it is possible for a class to work on two related units at the same time, in many classes the students progress better with just one.

The amount of time spent each week working on an USMES challenge is crucial to a successful resolution of the

problem. Each challenge is designed so that the various investigations will take from thirty to forty-five hours, depending on the age of the children, before some solution to the problem is found and some action is taken on the results of the investigations. Unless sessions are held at least two or three times a week, it is difficult for the children to maintain their interest and momentum and to become involved intensively with the challenge. The length of each session depends upon the age level of the children and the nature of the challenge. For example, children in the primary grades may proceed better by working on the challenge more frequently for shorter periods of time, perhaps fifteen to twenty minutes, while older children may proceed better by working less frequently for much longer periods of time.

Student interest and the overall accomplishments of the class in finding and implementing solutions to the challenge indicate when the class's general participation in unit activities should end. (Premature discontinuance of work on a specific challenge is often due more to waning interest on the part of the teacher than to that of the students.) However, some students may continue work on a voluntary basis on one problem, while the others begin to identify possible approaches to another USMES challenge.

Importance of the Challenge

Although individual (or group) discovery and student initiation of investigations is the process in USMES units, this does not imply the constant encouragement of random activity. Random activity has an important place in children's learning, and opportunities for it should be made available at various times. During USMES activities, however, it is believed that children learn to solve real problems only when their efforts are focused on finding some solution to the real and practical problem presented in the USMES challenge. It has been found that students are motivated to overcome many difficulties and frustrations in their efforts to achieve the goal of effecting some change or at least of providing some useful information to others. Because the children's commitment to finding a solution to the challenge is one of the keys to successful USMES work, it is extremely important that the challenge be introduced so that it is accepted by the class as an important problem to which they are willing to devote a considerable amount of time.

The challenge not only motivates the children by stating the problem but also provides them with a criterion for judging their results. This criterion--if it works, it's right (or if it helps us find an answer to our problem, it's

a good thing to do)--gives the children's ideas and results a meaning within the context of their goal. Many teachers have found this concept to be a valuable strategy that not only allows the teacher to respond positively to all of the children's ideas but also helps the children themselves to judge the value of their efforts.

Role of the Teacher

With all of the above in mind, it can be said that the teacher's responsibility in the USMES strategy for open classroom activities is as follows:

1. Introduce the challenge in a meaningful way that not only allows the children to relate it to their particular situation but also opens up various avenues of approach.

2. Act as a coordinator and collaborator. Assist, not direct, individuals or groups of students as they investigate different aspects of the problem.

3. Hold USMES sessions at least two or three times a week so that the children have a chance to become involved in the challenge and carry out comprehensive investigations.

4. Provide the tools and supplies necessary for initial hands-on work in the classroom or make arrangements for the children to work in the Design Lab.

5. Be patient in letting the children make their own mistakes and find their own way. Offer assistance or point out sources of help for specific information (such as the "How To" Cards) only when the children become frustrated in their approach to the problem. Conduct skill sessions as necessary.

6. Provide frequent opportunities for group reports and student exchanges of ideas in class discussions. In most cases, students will, by their own critical examination of the procedures they have used, improve or set new directions in their investigations.

7. If necessary, ask appropriate questions to stimulate the students' thinking so that they will make more extensive and comprehensive investigations or analyses of their data.

8. Make sure that a sufficient number of students (usually ten to twelve) are working on the challenge so that activities do not become fragmented or stall.

Student success in USMES unit activities is indicated by the progress they make in finding some solution to the challenge, not by following a particular line of investigation nor by obtaining specified results. The teacher's role in the USMES strategy is to provide a classroom atmosphere in which all students can, in their own way, search out some solution to the challenge.

USMES in the Total School Program

Today many leading educators feel that real problem solving (under different names) is an important skill to be learned. In this mode of learning particular emphasis is placed on developing skills to deal with real problems rather than the skills needed to obtain "correct" answers to contrived problems. Because of this and because of the interdisciplinary nature of both the problems and the resultant investigations, USMES is ideal for use as an important part of the elementary school program. Much of the time normally spent in the class on the traditional approaches to math, science, social science, and language arts skills can be safely assigned to USMES activities. In fact, as much as one-fourth to one-third of the total school program might be allotted to work on USMES challenges. Teachers who have worked with USMES for several years have each succeeding year successfully assigned to USMES activities the learning of a greater number of traditional skills. In addition, reports have indicated that students retain for a long time the skills and concepts learned and practiced during USMES activities. Therefore, the time normally spent in reinforcing required skills can be greatly reduced if these skills are learned and practiced in the context of real problem solving.

Because real problem-solving activities cannot possibly cover all the skills and concepts in the major subject areas, other curricula as well as other learning modes (such as "lecture method," "individual study topics," or programmed instruction) need to be used in conjunction with USMES in an optimal education program. However, the other

instruction will be enhanced by the skills, motivation, and understanding provided by real problem solving, and, in some cases, work on an USMES challenge provides the context within which the skills and concepts of the major subject areas find application.

In order for real problem solving taught by USMES to have an optimal value in the school program, class time should be apportioned with reason and forethought, and the sequence of challenges investigated by students during their years in elementary school should involve them in a variety of skills and processes. Because all activities are initiated by students in response to the challenge, it is impossible to state unequivocally which activities will take place. However, it is possible to use the documentation of activities that have taken place in USMES trial classes to schedule instruction on the specific skills and processes required by the school system. Teachers can postpone the traditional way of teaching the skills that might come up in work on an USMES challenge until later in the year. At that time students can learn the required skills in the usual way if they have not already learned them during their USMES activities.

These basic skills, processes, and areas of study are listed in charts and lists contained in each Teacher Resource Book. A teacher can use these charts to decide on an overall allocation of class time between USMES and traditional learning in the major subject disciplines. Examples of individual skills and processes are also given so that the teacher can see beforehand which skills a student may encounter during the course of his investigations. These charts and lists may be found in section E.

Ways In Which USMES Differs From Other Curricula

As the foregoing indicates, USMES differs significantly from other curricula. Real problem solving develops the problem-solving ability of students and does it in a way (learning-by-doing) that leads to a full understanding of the process. Because of the following differences, some teacher preparation is necessary. Some teachers may have been introduced by other projects to several of the following new developments in education, but few teachers have integrated all of them into the new style of teaching and learning that real problem solving involves.

1. New Area of Learning--Real problem solving is a new area of learning, not just a new approach or a new content within an already-defined subject area. Although many subject-matter curricula

include something called problem solving, much of this problem solving involves contrived problems or fragments of a whole situation and does not require the cognitive skills needed for the investigation of real and practical problems. Learning the cognitive strategy required for real problem solving is different from other kinds of learning.

3. Interdisciplinary Education--Real problem solving integrates the disciplines in a natural way; there is no need to impose a multi-disciplinary structure. Solving real and practical problems requires the application of skills, concepts, and processes from many disciplines. The number and range of disciplines are unrestricted and the importance of each is demonstrated in working toward the solution of practical problems.

3. Student Planning--To learn the process of problem solving, the students themselves, not the teacher, must analyze the problem, choose the variables that should be investigated, search out the facts, and judge the correctness of the hypotheses and conclusions. In real problem-solving activities the teacher acts as a coordinator and collaborator, not as an authoritative source of answers.

4. Learning-by-Doing--Learning-by-doing, or discovery learning as it is sometimes called, comes about naturally in real problem solving since the problems tackled by each class have unique aspects; for example, different lunchrooms or pedestrian crossings have different problems associated with them and, consequently, unique solutions. The challenge, as defined in each situation, provides the focus for the children's hands-on learning experiences, such as collecting real data; constructing measuring instruments, scale models, test equipment, etc.; trying their suggested improvements; and (in some units) preparing reports and presentations of their findings for the proper authorities.

5. Learning Skills and Concepts as Needed--Skills and concepts are learned in real problem solving

as the need for them arises in the context of the work being done, rather than having a situation imposed by the teacher or the textbook being used. Teachers may direct this learning when the need for it arises, or students may search out information themselves from resources provided.

6. Group Work--Progress toward a solution to a real problem usually requires the efforts of groups of students, not just individual students working alone. Although some work may be done individually, the total group effort provides good opportunities for division of labor and exchange of ideas among the groups and individuals. The grouping is flexible and changes in order to meet the needs of the different stages of investigation.

7. Student Choice--Real problem solving offers classes the opportunity to work on problems that are real to them, not just to the adults who prepare the curriculum. In addition, students may choose to investigate particular aspects of the problem according to their interest. The variety of activities ensuing from the challenge allows each student to make some contribution towards the solution of the problem according to his or her ability and to learn specific skills at a time when he or she is ready for that particular intellectual structure.

B. General Papers on School Zoo

1. OVERVIEW OF ACTIVITIES

Challenge:

Collect and maintain a variety of animals to help your class and others learn about them.

Possible Class Challenges:

How can we set up a zoo in our classroom that will help others learn about animals?

Children at all grade levels are interested in animals and how they live and grow. Maintaining a zoo in the classroom provides an opportunity for children to learn about animals and to share their learning with others. The "zoo" aspect of the challenge, which implies displaying the animals to other people, gives the unit a definite purpose and direction that prevent it from becoming a random study of animal behavior.

School Zoo might be introduced to a class in several ways. The challenge might arise when a student happens to bring to class an animal he/she has found. Another way the challenge might be introduced is through a discussion of how the students could find out more about living things near the school. The challenge may also arise during work on another USMES unit; for example, students working on the Nature Trails challenge might decide to learn more about the animals they find near their trail by keeping them in the classroom.

During class discussions the students may discuss animals already in the classroom and decide what additional animals they would like to bring in to provide the variety necessary for a zoo. They may realize the need to choose animals on the basis of size and suitability for captivity. The children may decide to work in small groups, each group working with a different type of animal. The groups will research information on their chosen animals to find out about their needs and habits. Some groups may decide to build or scrounge suitable containers for their animals before they bring them in, while others may bring in their animals and house them in temporary containers while they find or construct better ones. In discussing what size containers they should use, the children might consider what a comfortable living space would be. If they construct cages for their animals and have to decide what materials to use, they might conduct tests to see which materials the animals cannot destroy. They will also need to discuss whether a cage is "escape-proof"--can the animal jump or climb out or escape through the cracks?

Some of the chosen animals may be bought, but usually most are caught by the children themselves in the local area. Some children may decide to construct collecting

Linda Windham
Horace Mann

March 18, 1975
Room 260. 5th Gr.

Animal Poems

The gerbils tails are very long
There're just too long for that creature to own.
The rabbit's tail is as short as an ant
It should be long like the rabbits ears but it can't
The guinea pig's ears are as pink as pink grape that's why I never see them blink
The parakeet moves from side to side and sometimes they act like they're trying to hide
Well animals can do the strangest things and I wouldn't be surprise if I hear
One Sing! One Sing!
! ! One Sing!
! ! ! One Sing! One Sing!

devices such as insect traps. When the animals are settled in their containers, the students may decide that they need to observe their behavior to see if they seem to be comfortable and well cared for. Many children will realize the need to make the containers as much like the animals' natural environment as possible. They may decide that they need to conduct experiments to discover the animals' preferences for habitat or food. In this way they will be able to modify their care or containers in order to keep the animals healthy and comfortable.

One problem children might discover while planning long-term care of the zoo is the problem of maintaining a constant, inexpensive food supply. During the fall students will probably find that they can catch enough flies, worms, and other creatures to keep carnivorous animals happy and well fed. (They might, however, have to devise ways of trapping live flies if their animals show a distaste for dead ones.) During the winter this natural food source disappears and students may find the need to raise their own flies, earthworms, guppies, etc., for feeding animals such as amphibians or fish. They might also raise fresh vegetables for herbivorous animals such as guinea pigs. The students might better predict how much food or water animals will consume by measuring and graphing food and water consumption over a given period of time.

Other problems in long-term care might arise, such as providing warmth, food, or water over holidays or long weekends. Solving these problems might lead to the design of automatic feeders or to keeping certain animals in terraria complete with a constant food, moisture, and oxygen supply. Students may need to add heat in the form of a heating pad or light bulb so that animals can survive cold winter weather.

Students will enjoy making daily observations of animal behavior. They will be interested in seeing how animals play, care for each other, interact with animals of other species, and figure out their own problems, such as how to catch and eat a fly let loose in their container. They might try experiments to see how animals react to color, new objects in their cage, mirrors, or new kinds of food. Children may want to keep logs of their observations so that they can tell other people about them.

In order to make the zoo available to other people, the class may hold an open house for parents or other classes. The students might make displays about the animals, conduct tours of their zoo, or produce booklets or tapes conveying

JohnPaul FEB 26, 1976
I Fed The hamster
lettuce
I Fed The hamster Bread
I Fed The hamster
pieeza

information about the animals. This aspect could be the culmination of the School Zoo unit, providing a focus for all earlier activities.

To help other people learn how to care for an animal or maintain a zoo, the class might want to convey information by graphing their data, especially growth rates of young animals or food consumption. They might record observations on behavior and care and illustrate their perceptions with drawings and diagrams to help others understand them. Often, the class will find it necessary to give away surplus guinea pigs, gerbils, and other animals which have a habit of multiplying frequently. Children might want to prepare information on a particular animal to accompany the pet when it leaves the zoo for a new owner. When they decide to end their activities, the students will have to decide what to do with the animals. Should they give the zoo to other classes, take animals home, or let wild animals loose where they were found?

Work on the School Zoo challenge may lead to extensive studies of animal behavior or interest in the animals' natural environments. While caring for and observing their animals, the children may become interested in other USMES units such as Nature Trails or Growing Plants.

Although many of these activities may require skills and concepts new to the children, there is no need for preliminary work on these skills and concepts because the children can learn them when the need arises. In fact, children learn more quickly and easily when they see a need to learn. Consider counting: whereas children usually count by rote, they can, through USMES, gain a better understanding of counting by learning or practicing it within real contexts. In working on School Zoo, children also learn and practice graphing, measuring, working with decimals, and dividing to find averages or percentages.

2. CLASSROOM STRATEGY FOR SCHOOL ZOO

The School Zoo unit is centered on a challenge--a statement that says, "Solve this problem." The success or failure of the unit depends largely on (1) the relevance of the problem for the students and (2) the process by which they define and accept the challenge. If the children see the problem as a real one, they will be committed to finding a solution; they will have a focus and purpose for their

activities. If the students do not think the problem affects them, their attempts at finding solutions are likely to be superficial and lacking in direction.

The School Zoo challenge--"Collect and maintain a variety of animals to help your class and others learn about them"--is general enough to apply to many situations. Students in different classes define and reword the challenge and thus arrive at a specific class challenge. "Find a way to make a zoo in the classroom and share it with other children in the school" might be one class's interpretation of the challenge.

The Process of Introducing the Challenge

Given that a problem exists, how can a teacher, without being directive, help the students identify the challenge that they will work on as a group? There is no set method because of variations among teachers, classes, and schools and among the USMES units themselves. However, USMES teachers have found that certain general techniques in introducing the challenge are helpful.

One such technique is to turn a class discussion about animals toward a School Zoo challenge. For example, the teacher could ask the children to talk about experiences with animals, and the children might list different animals they have kept as pets or seen at the zoo. The teacher then might ask which animals could be kept in the classroom.

The teacher in a kindergarten class brought in some color photographs of animals in a zoo. She asked the class what kinds of homes these animals needed and whether large animals like those in the pictures could be kept in a classroom. When the children said that the animals were too big, the teacher asked if they could make a little zoo in the classroom and, if so, what kinds of animals they would want. The children were tremendously excited; they suggested gerbils, guinea pigs, frogs, butterflies, and many others. The following day some of the children brought in two grasshoppers, three caterpillars, and a toad and began finding comfortable containers for them to live in.

Frequently, the teacher or a child will bring animals into the classroom before the School Zoo challenge is introduced. In such cases the children may observe the animals

informally, and the challenge may arise naturally during a class discussion about their observations.

> *When one girl and the teacher in a fourth-grade class brought animals to school, the class discussed what animals would be good to keep in the classroom. Because the children were concerned about spending money for animals, the teacher suggested that they look on the school grounds for small native animals. After they listed the animals they could find on the grounds and made plans for a field trip to a nearby pond, the teacher asked what would be the point of having animals in the classroom. The children replied that they could "learn a lot" and that they could tell other children about animals "just like the guys at the zoo."*

A School Zoo challenge may arise from the children's work on another USMES unit. For example, children working on the Nature Trails unit may decide that they could study the animals from their area more closely if they kept them in the classroom.

When children working on another USMES challenge encounter a problem that leads to a School Zoo challenge, one group of children may begin work on this second challenge while another group continues on the first. However, there should be at least ten or twelve students working on any one challenge; otherwise the children's work may be fragmented or superficial or may break down completely.

The School Zoo challenge may also evolve during a discussion of a specific topic being studied by the class. A class studying animal physiology or behavior might decide that they can learn more by keeping animals in the classroom and observing their appearance and habits.

Classroom experience has shown that children's progress on a School Zoo challenge may be poor if the teacher and students do not reach a common understanding of what the challenge is before beginning work on it. Having no shared focus for their work, the children will lack the motivation inherent in working together to solve a real problem. As a result, they may quickly lose interest.

A third-grade class was not presented with a challenge; instead the teacher brought several animals into the classroom, along with the cages, food, and bedding the animals needed. The children divided into groups to care for the animals and spent some time observing them. However, without the motivation of a challenge to collect and maintain a variety of animals to help others learn about them, the children's activities were very fragmented. They viewed animal films, classified animals by sorting photographs, and wrote booklets about such animals as elephants and horses.

A similar situation occurs if the teacher, rather than ensuring that the children have agreed upon a challenge, merely assigns a series of activities. Although the teacher may see how these activities relate to an overall goal, the children may not.

Another third-grade class discussed animals and decided to buy some fish and make an aquarium. Later other animals were brought in. The teacher asked the children to keep records of the habits of various animals. However, the class had not discussed showing the zoo to other children, and without a focus for their record-keeping the students lost interest. Although they were still enthusiastic about the animals themselves, the children were not motivated to give them the proper care without continual reminders from the teacher.

Initial Work on the Challenge

When children begin work on their challenge, they list various tasks that need to be done, such as collecting or buying animals and making cages. Next, they usually categorize these tasks and set priorities for completing them. Most of these tasks were carried out by small groups of children. For example, one group might choose to make price comparisons of animals found at various pet stores, while another might research the diets of the animals the class plans to keep in the zoo.

As various groups complete their work, their members join other groups or form new groups to work on additional tasks. Usually, after the class has acquired several kinds of animals, a group will form to care for and observe each type

of animal. However, if too many groups are formed, work on the challenge can become fragmented. The teacher finds it impossible to be aware of the progress and problems of each group; in addition, having only one or two students in each group lessens the chance for varied input and interaction.

As the unit progresses, USMES sessions should be held several times a week, but they need not be rigidly scheduled. The children will need to prepare and follow regular schedules for feeding animals and cleaning cages, however. (The teacher may help by suggesting that they try alternative ways of making sure that these things get done.)

Refocusing on the Challenge

During work on School Zoo, the children's attention should, from time to time, be refocused on the challenge so that they do not lose sight of their overall goal. Sometimes children working on School Zoo become so involved with animal care activities that they forget about plans to show the zoo to other children in the school. In other cases, the construction of cages and containers may become a stumbling block to progress on the School Zoo challenge. If students spend a great deal of time building these containers from scratch before bringing in any animals, the construction may become an end in itself. An example of this is given below.

> *In a third-grade class the teacher discouraged children from bringing in ready-made containers for their animals because she wanted them to construct containers in the Design Lab. The children became very involved with the construction and lost sight of the challenge of collecting animals. The children were starting cages without knowing what animal they wanted to put into the cage, and they were not concerned about the size of the cage or the materials used. The students became discouraged at not finishing anything useful and soon lost interest.*

To keep children's attention focused on the challenge, teachers find it helpful to hold periodic class discussions that include group reports on their various tasks. Such sessions help the students review what they still need to do in order to complete the zoo and to show it to others. These discussions also provide an opportunity for students to evaluate their own work and exchange ideas with their classmates.

Resources for Work on the Challenge

During the course of the School Zoo unit, a teacher may become concerned for the welfare of the animals in the zoo. Then he or she is faced with the question: Should I interfere? For instance, the teacher may feel that the children are selecting some animals for the zoo that are inappropriate for a classroom, such as dogs or cats.* The teacher might also observe childish cruelty, carelessness, or neglect in students' behavior towards the animals in the zoo.

Before the teacher speaks out, the children themselves might change their approach.

> *When one child in a fourth-grade class suggested that the class keep a dog in the zoo, many children thought it would be fun. But as the discussion progressed, more and more children brought up objections: a dog would get lonesome, it might make messes, it might bark during a test. The children decided to make a list of things to think about when they decided on animals so that they wouldn't get animals like dogs that were too bothersome.*

If a student is treating an animal carelessly or cruelly, other students in the class will usually notice and will try to protect the animal.

If the children do not recognize that their approach or behavior is harmful to animals, the teacher might ask questions that stimulate the children to think about their values and sense of responsibility. Sometimes the teacher might need to ask the class only whether they think the animals are healthy and happy or what things could be done to improve their lives. At other times more pointed questions asked by alert teachers could avoid many animal deaths, injuries, or illnesses; for example, a teacher might ask children how they could tell whether two animals are compatible before they house them together in a cage for the weekend.

The technique of asking open-ended questions is also useful when children encounter other difficulties during their

*Children may also want to trap wild birds or mammals. These animals are usually unhappy in captivity. Some states have laws against keeping certain wild animals. We particularly do not recommend wild mammals as classroom pets because they occasionally carry rabies or other diseases.--ED.

investigations or try to decide on solutions before collecting enough data. These questions stimulate the children to think more comprehensively and creatively about their work. For example, instead of telling a student that his conclusions about his guinea pig's preference for carrots should be retested several times, the teacher might ask the student whether he thought the guinea pig always liked carrots best and how he could tell. Examples of other nondirective, thought-provoking questions are given at the end of this section.

The teacher may also refer to the "How To" Cards relating to School Zoo for information about specific skills, such as making an animal home or drawing graphs. If many students or even the entire class need help in particular areas, teachers should conduct skill sessions as these needs arise. (Background Papers on topics relating to School Zoo activities may be helpful.)

USMES teachers can also assist students by making it possible for them to carry out tasks involving hands-on activities. If the children's tasks require them to design and construct items, such as animal cages, the teacher should make sure that they have access to a Design Lab. Any collection of tools and materials kept in a central location (in part of the classroom, on a portable cart, or in a separate room) may be called a Design Lab.

Valuable as it is, a Design Lab is not necessary to begin work on School Zoo. The Design Lab is used only when needed, and, depending on the investigations chosen by the children, the need may not arise at all.

A third-grade class worked on School Zoo activities without using the Design Lab. They housed insects in jars and shoeboxes lined with plastic, used a child's wading pool for crayfish, and made a caterpillar house out of cardboard and cheesecloth.

To carry out construction activities in schools without Design Labs, students may scrounge or borrow tools and supplies from parents, local businesses, or other members of the community. The extent to which any Design Lab is used varies with different classes because the children themselves determine the direction of the School Zoo investigations.

Culminating Activities

School Zoo activities generally continue until the children have collected and maintained a variety of animals and shown them to other people. An "open house" where zoo animals, cages, reports, and drawings may be displayed provides an excellent focus for student activities. Without this culminating activity, many classes have trouble deciding if or when they have reached a solution to the challenge. Besides making displays, students may show films, play tapes, or give guided tours to teach others what they have learned about animals.

3. USE OF SCHOOL ZOO IN THE PRIMARY GRADES

Most young children like animals and enjoy the responsibility of caring for them. In some classes, when an animal has been part of the class environment for a week or more, the teacher may ask the children if they would like to keep several animals in the classroom. The children usually respond enthusiastically to this challenge. In other classes young children bring animals they have found (such as grasshoppers, toads, etc.) into the classroom to show the other children. This may lead to a class discussion about how they could find other animals and start a zoo. In one school a kindergarten teacher introduced the School Zoo challenge to her class after a discussion of public zoos and what kinds of animals could be kept in a small classroom zoo.

In discussing what should be included in a small classroom zoo, children search for animals that show variety in their physical characteristics and behavior. A third-grade class found fish, crayfish, snakes, field mice, and quail to bring into the classroom. Children in a kindergarten class brought toads, grasshoppers, caterpillars, a turtle, a spider, and a cricket for their classroom zoo. The students avoid animals that are not suitable for captivity or that need too much care. Children in a first-grade class decided they would choose only animals that they thought would be happy in the classroom.

Primary children may work for many weeks on the School Zoo challenge as they collect new animals on a regular basis, prepare comfortable environments, follow feeding schedules, and observe and record details about the animals' characteristics and behavior. Young children start spontaneously to observe their animals soon after bringing them into the classroom. They watch their animals eat, play, raise babies,

and groom themselves. A first-grade class watched a mouse give birth to its young. Children "experiment" with animals by placing them in new environments and noticing their behavior, putting two animals together to see how they react to each other, and finding out what kinds of food they prefer. Another first-grade class tested their guinea pigs to see whether they preferred carrots or celery. A kindergarten class found out that they could get their toads to eat dead flies only if the flies were floating in water.

If the need arises, most primary classes will be able to construct simple containers for their animals. A third-grade class built a large hanging cage for caterpillars and made homes for worms out of cardboard boxes lined with the plastic and filled with dirt. Children in a kindergarten class constructed cardboard "houses" for grasshoppers, using knives from the school kitchen.

Measurement skills are learned as primary children measure or weigh animals to find out which animal is biggest or how fast their animal is growing. A first-grade class with two guinea pigs placed both on the balance to see which was heavier. The children also measured how long and how tall each guinea pig was and weighed crayfish by using washers as a unit of weight. Children might also measure the amount of food or water their animals consume.

Children may record their data on line graphs or bar graphs. Students in a first-grade class taped a chart to the side of their fish tank and recorded the water level each day. After a skill session in graphing they made a line graph showing amount of evaporation over a three-week period. Children may make simple bar graphs of animal weights or other data by cutting strips of paper to a fixed length and sticking them on paper or by piling erasers on the chalkboard tray and drawing lines around them.

Telling others about their animals and the zoo provides many good opportunities for children to practice the language arts. A first-grade class began the year by dictating experience stories about their guinea pigs. Later in the year they composed booklets on the care of the guinea pigs that showed careful organization and planning. A kindergarten class made a tape recording on guinea pig care and played it at an open house for parents.

Young children express themselves naturally and easily in the visual arts as they paint pictures of their animals and illustrate booklets or display boards about them.

November 3 1975
we bought fur fish. cherry barb, penguin, blck neon, gold sword.
the new guppys are not guppys.
they are called native fish.

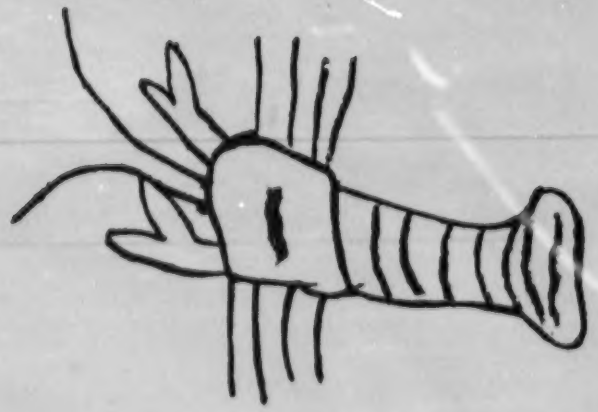
Irene FAz

4. FLOW CHART

The following flow chart presents some of the student activities--discussions, observations, calculations, constructions--that may occur during work on the School Zoo challenge. Because each class will choose its own approach to the challenge, the sequence of events given here represents only a few of the many possible variations. In addition, no one class is expected to undertake all the activities listed.

The flow chart is not a lesson plan and should not be used as one. Instead, it illustrates how comprehensive investigations evolve from the students' discussion of the School Zoo problem.

CRAYFISH



John

Challenge: *Collect and maintain a variety of animals to help your class and others learn about them.*

Optional Preliminary Activities:

Class pet or animal brought in by children.

Other USMES Units:
- *Ways to Learn/Teach*
- *Nature Trails*
- *Growing Plants*

Field Trips: *Nature Center, Zoo, Aquarium, Museum*

Possible Student Activities:

A few animals are brought into classroom, housed in temporary containers, and cared for. Animals are observed informally at first with schedules for housekeeping and observation set up later.

Discussion of possibility of keeping animals in classroom for longer periods.

Class Discussion: What is a zoo? Why are zoos important? How could we make a zoo at school? What types of animals can we keep in the space available? What do the animals need (homes, food, water, etc.)?

Observation of animals already in class, to find out what better care they need.

Collection of animals outdoors and purchase of rodents at pet store; housing in temporary containers.

Researching information on what local animals can be captured and kept in the class.

Purchasing, scrounging, collecting food for animals. Growing of food (flies, earthworms; plants) needed.

Class Discussion: What variety of animals do we want for our zoo? Which animals will live together? How are these animals different from each other? What can we learn from them?

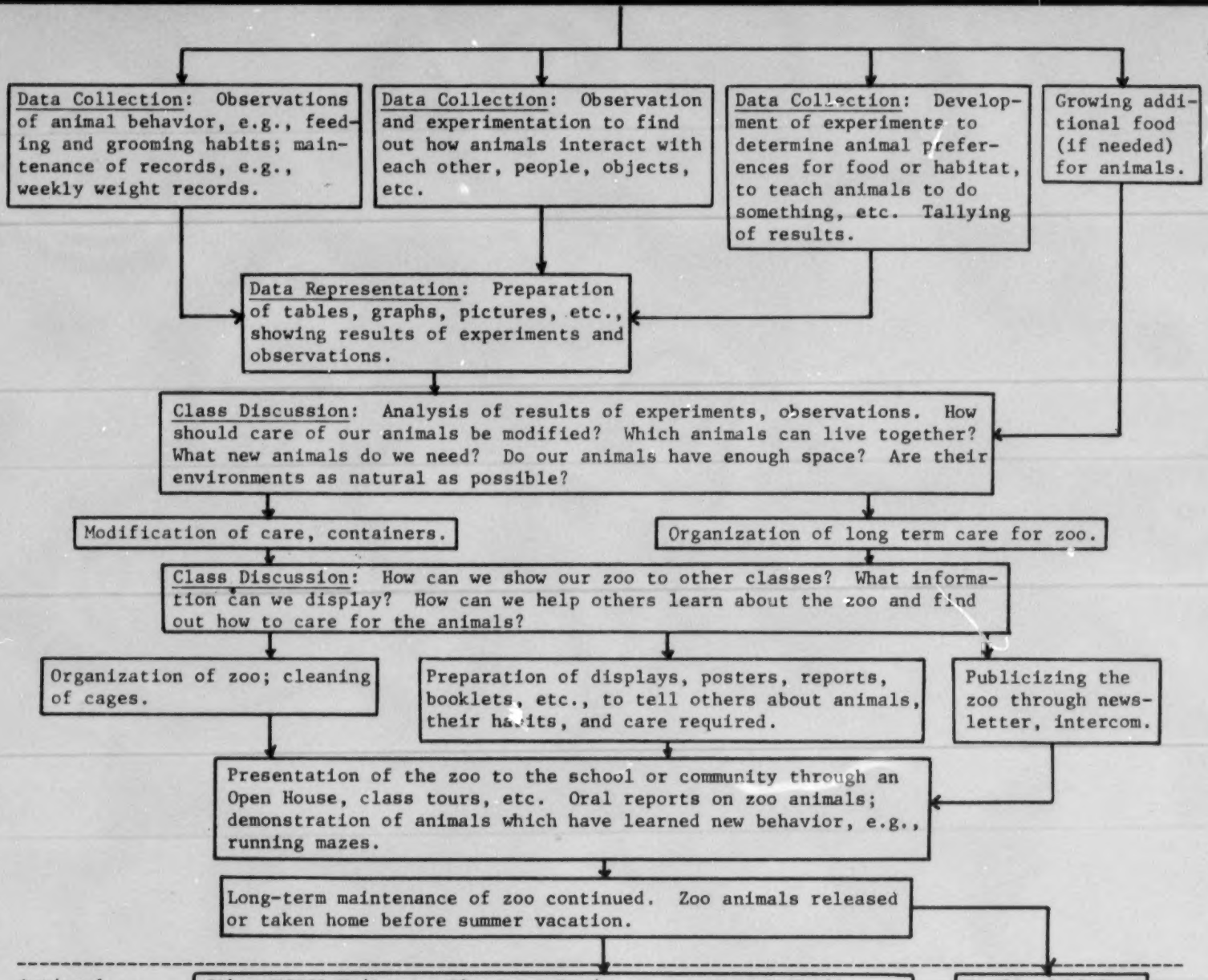
Collecting new animals. Scrounging or designing and building of collecting devices, insect traps, etc.

Researching needs of animals already in class, other animals for zoo.

Scrounging, or designing and building, of containers for animals, making them as natural as possible.

Preparing food and water schedules for animals. Arranging regular food supply.

Class Discussion: What can we learn from observing our animals? What types of foods or habitats do they prefer? How do the animals act toward each other? Toward people? How can we improve their lives?


Data Collection: Observations of animal behavior, e.g., feeding and grooming habits; maintenance of records, e.g., weekly weight records.
Data Collection: Observation and experimentation to find out how animals interact with each other, people, objects, etc.
Data Collection: Development of experiments to determine animal preferences for food or habitat, to teach animals to do something, etc. Tallying of results.
Growing additional food (if needed) for animals.
Data Representation: Preparation of tables, graphs, pictures, etc., showing results of experiments and observations.
Class Discussion: Analysis of results of experiments, observations. How should care of our animals be modified? Which animals can live together? What new animals do we need? Do our animals have enough space? Are their environments as natural as possible?
Modification of care, containers.
Organization of long term care for zoo.
Class Discussion: How can we show our zoo to other classes? What information can we display? How can we help others learn about the zoo and find out how to care for the animals?
Organization of zoo; cleaning of cages.
Preparation of displays, posters, reports, booklets, etc., to tell others about animals, their habits, and care required.
Publicizing the zoo through newsletter, intercom.
Presentation of the zoo to the school or community through an Open House, class tours, etc. Oral reports on zoo animals; demonstration of animals which have learned new behavior, e.g., running mazes.
Long-term maintenance of zoo continued. Zoo animals released or taken home before summer vacation.
Optional Follow-Up Activities:
Other USMES Units:
• Classroom Design
• Protecting Property
• Advertising
• Nature Trails
• Growing Plants
• Consumer Research
Study of biology or anatomy.

5. A COMPOSITE LOG

This hypothetical account of an intermediate-level class describes many of the activities and discussions mentioned in the flow chart. The composite log shows only one of the many progressions of events that might develop as a class investigates the School Zoo challenge. Documented events from actual classes are italicized and set apart from the text.

Shortly after school begins in the fall, one child in the class brings in a frog that she found on the way to school. As the class gathers to observe and discuss the animal, the teacher asks if they would like to keep the frog in the classroom. The children are very enthusiastic about the idea and start to plan what to keep the frog in and how to feed it. When the teacher asks if they think there are other animals that they could keep in the classroom, one child lists their suggestions; snakes, lizards, mice, rabbits, fish, etc., on the board. When children suggest lions and chimpanzees, the teacher questions them as to whether they really could keep such animals in the class and why not.

The discussion focuses on what the animals would need. The first thing the children suggest is food. When the teacher asks if they could feed all the animals the same kind of food, the students agree that each animal would have to have the sort of food it needs. Some animals might need grass, others insects, others carrots, etc. The students then list water, air, a place to sleep, room to run around, and "company" as other things animals need.

A fifth-grade class in Boulder, Colorado, discussed bringing animals into the classroom and listed the things they would have to think about before they brought an animal in. These included the following:

1. *size of animal*
2. *method of obtaining animal*
3. *what it can eat*
4. *what it can do*
5. *diseases the animal can catch*
6. *safety precautions for animal handlers*
7. *conditions for living: (a) temperature, (b) comfortable surrounding, (c) past environment*
8. *breeding*
9. *life expectancy*

The students set out to find out as much of this information as they could from library books and pet shop materials. (From log by Kathleen Schultz.)

The class discusses zoos that the children have visited and why zoos are important. The children think that people

*Written by USMES staff

enjoy watching animals and can learn a lot about them from a zoo. They decide that a zoo needs a variety of animals. The teacher then issues the challenge, "Collect and keep different kinds of animals in the classroom. Learn about them and teach others about them." The children talk about preparing their zoo for other children to see later in the year.

A fourth-grade class in Burnsville, Minnesota, became interested in animals and began to look around outside for insects, snakes, and other animals which could be captured and brought into the classroom. After they had planned a trip to a nearby pond to look for more animals, the teacher asked the children if they would like to make their own zoo in the classroom. The children eagerly said, "Yes," and made plans for housing them and caring for them. One child suggested that they could invite children from other classes to come in "Just like in a real zoo." The children began designing and constructing homes for various animals and soon after brought them into the classroom. (See log by Marion Twaites.)

When the challenge is given, the children enthusiastically begin to decide what animals they will have in their zoo. Some students get books from the library to find out about the care of pets and what animals live wild in the area. From their research they get a better idea of the choices available to them. The children decide that they need to observe the animals in the classroom carefully because this will help them to choose other animals to get and will tell them what their animals need. They decide to record every day anything they notice about their animals.

A third-grade class in Lexington, Massachusetts, decided that the best way to keep track of things that happened to their animals was to take notes. Several methods were suggested: (1) each person keep a notebook, (2) the whole class keep one notebook, (3) keep a running list with the date on the board, (4) keep a huge calendar which children can fill in after they see something. The class decided that the calendar was the best method. (From log by Phyllis Viall.)

The class decides that each animal should be discussed by the whole class and voted on. One child says he wants a snake in the zoo, and the other students agree with this "so long as it's not poisonous." Other animals that are suggested are gerbils, fish, crayfish, toads, lizards, birds, and a cat. The class decides that it's "not fair" to keep wild birds in captivity because they need room to fly. One student suggests a parakeet, and the class agrees this would be all right if they can afford it. The student who has made the suggestion volunteers to look into the cost. After discussing the keeping of a cat in the classroom, the children decide that it would not be suitable because a cat is a large animal that needs a lot of attention and exercise. The children make a rule for themselves that no animal as large as or larger than a cat will be included in the zoo.

Students in a first-grade class in Ganado, Arizona, talked about bringing insects they had found on the playground into the classroom. When the teacher asked them what kinds of animals they could have in the classroom, the children shouted out all kinds of animals, including a polar bear, a monkey, and a Chinese cat. However, the children visited a small zoo in Window Rock for animals that had been hurt and could not survive without help. Upon returning to the classroom, they decided to eliminate from their list animals such as cats and foxes that would not be happy in the classroom. A few days later, someone suggested catching an eagle, but one girl said that eagles should be left alone to have babies "so there will be some left." (From log by Barbara Braun.)

The class divides into several groups. Each group is to be in charge of one of the sorts of animals chosen to be included in the zoo. The children in each group are responsible for finding out about their chosen animal, finding or making a place for it to live, obtaining the animal, and looking after it properly.

The group that is in charge of the frog decides that they want to have lots of different frogs and toads. They discuss whether they should have a separate container for each different kind and decide it would be easier to make one large container for all of them. One child suggests that

they keep the frogs in an aquarium full of water because frogs swim. Others argue that since frogs go on land as well, there ought to be some land in the frogs' environment. To resolve the problem, the children look up frogs in the encyclopedia and discover that they do indeed need land and water. The children decide that they can temporarily keep the frog and any others that they find in a plastic hatbox with a bowl of water in it. The next day one of the group brings a hatbox from home, and they transfer the animal from its small jar to the more spacious hatbox. When the frog promptly jumps straight out of the hatbox, the children realize the need for a covering over the top. One child points out that the frog also needs air, so the students punch holes in the box cover. Later, they make a better cover for the frog home out of wire screening.

Children in a kindergarten class in Iowa City, Iowa, found a small grass frog which they decided to add to their zoo. One boy used a ruler to measure how far the frog could jump and then went to look for a box that was taller than this figure. (See log by Susan Marquis.)

Sixth-grade students in Monterey, California, decided that they should build a stream box to house the frogs and toads. The box was landscaped with gravel, dirt, and sand and had a pond at one end with a water pump to circulate the water to the top of the "stream." All the frogs and toads and several plants were placed in the stream box. (From log by Steven Hanson.)

The group of students who have elected to be in charge of fish are discussing where to purchase them. One girl says she knows a creek where you can catch little fish. The children are immediately attracted by the idea of catching their own fish instead of buying them and begin to discuss how to go about this. They decide that they need a net to catch the fish. Since none of the students possesses a net, they decide to make one in the Design Lab. Two students soon fashion one using a length of dowel, a coat hanger, and nylon netting made of old panty hose.

While these students are working, others in the group are finding books in the library on how to keep aquaria. The

children remember seeing an empty aquarium in the science room, and one girl volunteers to ask the teacher concerned if they can use it. When her mission is successful, the group puts gravel and water in the aquarium right away because they learn from a book that tap water has to stand for several days before the animals can be safely put in it.

The children who want to keep crayfish know a creek where they can find them. They bring four fine specimens to school. They plan to get a child's wading pool to house them all, but they temporarily keep each in a separate bowl of water.

The third-grade class in Lexington bought two "Blue Whales"--wading pools approximately 5' x 3' in the shape of a fish. They used one to hold their crayfish and the other for observing fish and crayfish during class. (From log by Phyllis Viall.)

Even though they have found as many animals as possible outside, the children realize that any larger animals they choose to work with, such as gerbils, must be purchased. They hold a class discussion to figure out a way to raise money for their zoo, and the class decides to ask the PTA and try it out on their class first. The improvements suggested during the trial certainly helped; the presentation is a success. The PTA gives the class enough money to buy construction materials for cages, food for animals, some gerbils, and some chameleons.

Children in a fifth-grade class in Chicago, Illinois, could not find all the animals they wanted outside. In order to buy pets such as gerbils, hamsters, or guinea pigs for their zoo, they needed to raise money. They held a bake sale for the other fifth graders in the school and then listed the materials they wanted to purchase with the money, including guinea pigs, fish, gerbils, water bottles for the animals, wood, and food. Later, the children managed to find a store which gave them vegetables to feed some of the animals, and other people gave them bags of grain for feed. (See log by Cynthia Wychocki.)

Five children who want to work with gerbils form a group for this purpose. They buy a book on gerbils from a pet store. A girl in the school has a litter of gerbils, and the children obtain a male and female from her. They also borrow a cage to house the gerbils in temporarily while they make a home for the gerbils. Knowing that their animals gnaw things, they are not sure which material would be best to use. They decide to make a test. Using scraps from the Design Lab, they put one sample piece of material in with the gerbils each day. The first day they put in a piece of Tri-Wall, the next day a piece of Plexiglas, then plywood, and then metal screen. They inspect each sample after a day to see how much the gerbils have chewed it. They find that the Tri-Wall is completely shredded, and the wood is nibbled all around the edge, but the gerbils have not managed to destroy the Plexiglas or the screen. The children decide to make a container of Plexiglas taped together with duct tape and covered with screening. They start drawing their plans for the construction.

The children in the Boulder class finished their designs for cages and cut the pattern out of newspaper to be sure the cage would fit together properly. They then laid out the pattern to work out how much wood or other material they would need. They phoned lumber yards to find the best buy and had to do a lot of math to work out the cost per square foot when prices were quoted per sheet. (From log by Kathleen Schultz.)

Children in the Chicago class designed wooden cages for gerbils, hamsters, and guinea pigs. Working in groups, the students first designed their cages on paper and estimated the dimensions they needed. Then they measured, cut, and sawed the wood and nailed the frame together. They cut out pieces of wire screening and fastened them to the sides. (See log by Cynthia Wychocki.)

To their surprise, the group that wants a snake manages to capture a small garter snake without much difficulty and brings it triumphantly into the class. They keep it temporarily in a large catering jar with grass in the bottom and cheesecloth secured over the top. When they discuss

2. What's the animals favorite singer?
answer Harry Elephantee

1. What was ~~the~~ a turtle doing on the New Jersy Turnpike?
answer about 2 miles an hour

the problem of housing the snake, they decide to join forces with another group which has bought a chameleon at the pet store. They decide that because both animals are reptiles and need some warmth and some vegetation in which to hide, they can probably live together. They plan to make a cage of wood, Plexiglas, and screen with an incandescent light bulb for warmth.

In a seventh-grade class in Marietta, Georgia, a group of students working with a snake made a home for it in another old aquarium with screen wire taped to the top to prevent escape. They provided it with tall grass, a branch, and a pool of water and fed it with worms and crickets. (From log by Martha Jamison.)

The boy who wants a parakeet telephones several pet stores to find the price of a parakeet, a cage, and the various supplies he would need. The class thinks it is too expensive for their zoo, but as he is very enthusiastic about the idea, he buys the parakeet with his own money.

The children decide that they should carefully observe their animals to decide what things they need and whether they are comfortable. Students keep daily logs of their observations, written during the period when they clean the cages and feed the animals.

Children in the Burnsville class kept notes on the day-to-day progress of their animals. They tried several experiments with animals, such as changing the color of the water in the aquarium by adding food coloring and observing how the fish behaved. The children were also successful at training their two rats to run mazes and kept records of the amount of time for each trial. (See log by Marion Twaites.)

A first-grade class in Lexington, Massachusetts, was given several crayfish by children in the third grade. After observing them for several weeks, the children dictated these observations to the teacher, who wrote them down:

Our School Crayfish

Our crayfish live in water. They live in clean, shallow water. They live in shallow water because they need only enough water to wet their gills to breathe out of. They need water to swim. A crayfish uses his claws to eat. They have two claws, eight legs, two antenna and one tail. Some crayfish only have one claw because they fought each other for food and for more room. The crayfish have two eyes. They move sort of fast. They move backwards the best. They have legs to walk with. They have more legs than us. We have two, they have eight. Some only have six. They have no arms but they have claws instead. They sort of eat like what fish eat. At the bottom of their tails they have stingers. Crayfish do not hurt. Crayfish are about two inches.

The End.

(From log by Judith White.)

As each animal is brought in, the children set about providing it with the food it needs. Commercial food is bought for the gerbils and parakeet, but the other food is caught by the children themselves. They catch flies, crickets, moths, beetles, and earthworms for the chameleon, snake, frogs and toads. (More frogs and toads have been added to the classroom zoo.) Earthworms are cut up to feed the crayfish. The small fish in the zoo are provided with a varied diet of small aquatic animals caught with the children's net.

The class in Monterey decided to raise flies to feed the reptiles and amphibians they were keeping. Adult flies were placed in a gallon jar with a container full of a mixture of bran and diluted evaporated milk. Some eggs were laid and hatched into maggots. These made cocoons but no adults ever hatched. To feed their frogs, they caught various kinds of insects and placed them in a box from which they could crawl into the frog container. (From log by Steven Hanson.)

The children in the gerbil group conduct experiments to determine their animal's preferences for certain foods. One day they give the gerbil a choice between two foods and see which it prefers. Then the next day they offer one of that pair of foods with a different food and thus construct an order of preferences.

The children in a first-grade class in Lexington, Massachusetts, brought carrots, celery, and lettuce to school and placed each vegetable in a pile on the floor. They put their guinea pigs down and watched to see which vegetable they ate. The children noticed that they preferred both lettuce and celery, which are green and leafy, to carrots. They made a chart of the guinea pigs' preferences by drawing happy faces next to celery and lettuce and a sad face next to the carrot. (See mini-log by Judith White.)

Various animals continue to arrive in the classroom; a salamander and a newt are found by the frog hunters and are placed in the container with the frogs and toads. The fish catchers find two mud puppies (salamanders), which are put in their aquarium. A turtle found by a child in another grade is given to the class. The turtle is placed in the large frog environment.

As the aquarium begins to get crowded, the water gets cloudy despite the water plants the children have added, and the class decides this problem needs to be discussed. During the discussion one student says that his family's aquarium has an air pump and filter and that maybe the class should try it. The aquarium group finds that the science room has a pump and filter and sets it up in the aquarium. Fortunately, this cures the problem before any deaths occur.

The frog and toad group is not so lucky, however, and a cold weekend causes the deaths of two small toads. The children have planted grass, dandelions, and other plants in the toad container to make it more natural; during a class discussion of what to do about the deaths, someone suggests burying the bodies in the container "to make the plants grow."

Two frogs collected by the Marietta class died later in the term, probably because of the cold on the weekends when the heating was turned off. The bodies were buried in the dirt of the container to enrich the soil for the plants. (From log by Martha Jamison.)

After the children's concern for the animals is heightened by the deaths of the toads, the class meets to discuss the welfare of the animals and the success of their zoo to date. Each group reports on its animals--how they are being housed and cared for and whether they seem "happy." After each group's report, the class discusses how the container could be made more comfortable and more like the animal's natural environment. In many cases the children decide that they should add more plants to make it more natural. The students decide to release the garter snake because it has not eaten for several weeks and looks sick.

During the next class discussion the students talk about how each group can tell if their animal is really healthy. They decide that a young animal will grow if it is healthy and that any animal will probably lose weight if it is sick. They plan to weigh their animal at least once a week and keep records. If the weight starts to go down, they will release the animal. The children decide it would be very difficult to weigh the fish, the mud puppies, or the parakeet, and so they think of other methods of keeping track of the progress of these animals. They agree to observe all the animals very carefully at least once a week and to write down all they can about appearance and behavior so that they can notice whether any animal "looks funny." Another thing they decide to do is to start measuring how much food and water each animal consumes so that they can tell if an animal loses its appetite. After collecting data for several weeks, the children start making bar graphs of both the daily weight and food consumption of their animals.

Children in the Marietta class kept records of their snake's growth by measuring its length every week. They made a bar graph of their data. (From log by Martha Jamison.)

In the kindergarten class in Iowa City, children used a postal scale to weigh their baby guinea pigs.

They took two sets of measurements a few days apart to see how much the young ones had grown. The children also had toads of different sizes, and one boy measured each and recorded the length on a chart. (See log by Susan Marquis.)

The first graders in Ganado, Arizona, made a chart for measuring evaporation of water from their fish tank. They taped the chart to the side of the tank and measured the amount that evaporated each day. The children began measuring in fractions of inches, but they switched to millimeters because they were easier to use. After the teacher conducted a skill session in graphing, the children made a line graph showing how much the water level had dropped over a two-week period. (From log by Barbara Braun.)

As various problems in the care of the animals arise, the class meets to discuss how they can be solved. Still concerned about the cause of the toads' deaths, they decide to measure the temperatures of their various animal containers. Using a regular thermometer, they measure the temperature in all the containers during the school day, but then they realize that the main problem occurs at night and during weekends when the heat is turned off. To solve this problem, the children use a maximum and minimum thermometer to find how cold each of the cages becomes overnight. They find out that it sometimes gets down to $10^{\circ}C$ at night.

The frog group decides their environment needs heating when the school heating is turned off. They place a heating pad under one side of their frog container and turn it on at the end of each school day. The animals can then choose to be near the heating pad if they want warmth or farther away if they are too hot.

In the Boulder class two boys who were caring for a couple of mice read that mice liked the temperature between $70^{\circ}F.$ and $75^{\circ}F.$; so they built a fan, with the blade mounted on a wooden dowel and powered by a battery, to cool the mice when it got hot and stuffy. However, this was March, and the temperature was not high enough for the mice to need the fan, which the boys found very frustrating. Then, to their consternation, they found the temperature in the cage

was only 60°F., and they rigged a light bulb inside a cardboard box and left it to heat the cage. (From log by Kathleen Schultz.)

As winter sets in, insects for the turtle, frogs, and toads become increasingly difficult to find. The class tries to catch houseflies to set up a breeding colony but realize that there are few flies around and that they must wait until spring to start their colony. In the meantime they buy mealworms from the pet store.

As the Christmas vacation approaches, the children discuss what to do with the animals over the vacation. Weekend feeding has been managed by giving the animals twice as much food on Friday. However, regular feeding is necessary during the vacation. The class decides to take all of the animals home. Each student who brings in a permission slip from his/her parents takes one or more animals home for vacation.

The Marietta children decided very reasonably what to do with the animals over the Christmas vacation. The box turtles and the snakes were all trying to hibernate, so the students felt they could all be left safely in school with just a supply of worms. The frog-tadpole-turtle environment caused more difficulty as fresh creek water had to be added every week; however, a student volunteered to come in when the building was open to change the water. The gerbils and the two hamsters were taken home by students. (From log by Martha Jamison.)

The students in the Chicago class prepared for each long vacation by bringing in permission slips signed by their parents which allowed them to take home an animal. Just before each vacation, students carefully cleaned each cage and groomed their animals so that they would look their best at home. After vacation, the children spent their first day back at school exchanging stories about how their animals acted at home. (See log by Cynthia Wychocki.)

After vacation all the animals are returned to the zoo, and the class discusses what they should do next. Most of

I Are you tired of ~~[illegible]~~ smelling your animal's breath? Here's a new product called Binoca Blast for Animals. It comes in Two different flavors. For 4 sunflowers seeds at ~~[illegible]~~ school zoo Guinnea GREEN + Rabbit RED.

the problems of maintaining the zoo have been worked out, and in January not many animals are around to add to the zoo. The class decides this would be a good time to start making the zoo available to other children in the school. The class discusses how they can help other children learn from their animals and talks about what happens at "real" zoos. They decide that each cage should have a label saying what animal is in it. For those cages containing different sorts of animals, they decide to draw a picture so that the visitors can tell which animal is which. They think they should make posters about each animal, telling things about how to care for the animal and how it lives in the wild. Each group is given the responsibility of labeling its cages and making a poster about its animal(s).

The first-grade class in Lexington decided to write books about the guinea pigs they were keeping in the classroom. They wrote one book about how to clean the guinea pigs' cage and another on how to measure and weigh the guinea pigs. The children also made a slide/tape show to tell next year's first grade how to look after guinea pigs. (See mini-log by Judith White.)

The class then discusses how they will show the animals to other children. Some students don't want to give guided tours ("I wouldn't know what to say"), but the entire class thinks someone should be there to see that the animals are not harmed. They decide to "open" the zoo two days a week during recess and to let other children come in to see the animals. Two class members will stay in the room during recess to be "Zoo Keepers", looking after the animals and answering any questions the children have.

The class diligently make their animal posters, and one girl who is good at drawing makes a poster of their various animals to advertise the zoo. This is then placed on the door. They also make an announcement over the school intercom system.

The fifth-grade class in Chicago advertised the opening of the zoo by putting on a "radio show" over the

3 Are you down with the samecld animals on the street and you want to see something If so come to room 260S School ~~School~~ May 12-16 See you there

school intercom system and calling it "W USMES." They made up stories, poems, and songs about their animals, played music, and told animal jokes, even producing their own "canned laughter." The children received many compliments on their show, which also brought a tremendous turnout to their Open House the following week. (See log by Cynthia Wychocki.)

The zoo is a great success: many children visit the animals. Whenever a new animal is added to the zoo and seems comfortably settled, the new animal is announced over the intercom and draws more visitors. There is great excitement when a litter of baby gerbils is born, and visitors have to be banned from the room for a couple of weeks so that they don't disturb the mother.

The visitors cause some problems. Despite the presence of the "Zoo Keepers," some visitors interfere with the animals and even let some animals loose so that locks have to be put on some of the cages. Another problem is that the parakeet becomes disturbed by the noise of the visitors. To solve this problem, the parakeet's owner measures the noise level in different parts of the room with the "magic eye" of a tape recorder. He moves his bird to the quietest corner, away from most of the traffic.

The fourth graders in Burnsville decided to hold their Open House during the school art fair in April. The children made extensive preparations, including a floor plan of the zoo to help visitors, information charts on the animals, and posters advertising the Zooroom (as they called the zoo). They also trained several of their animals to "perform" for their visitors. Rats, gerbils, and guinea pigs ran mazes, and the rats were instructed to climb a ladder and go down a slide. The zoo was so popular that visitors to the Open House had to wait in a long line to see the animals. (See log by Marion Twaites.)

As spring comes, more animals are captured and added to the zoo: turtles, lizards, snakes and tadpoles. Some are housed alone; others are added to existing containers if they can coexist with the animals already there and if they

will be at home in that sort of an environment. In some cases the containers themselves are enlarged to make room for the newcomers. The class holds a discussion to evaluate the variety of animals in the zoo. They decide their zoo needs some insects and "crawly things," and small groups set up an ant farm and an earthworm house.

The class in Marietta reported that the zoo continued to expand throughout the year. Animals that arrived during the spring included another stink pot turtle, a painted turtle, a tree frog, another box turtle, crayfish, a fence lizard, several Dekay snakes, a worm snake, a bull snake, and some small lizards. (From log by Martha Jamison.)

Two cocoons which children in the Chicago class had kept in the classroom all winter suddenly produced two beautiful moths. The first one died before they could let it go, but the second one was released after the children had examined and admired it thoroughly. (See log by Cynthia Wychocki.)

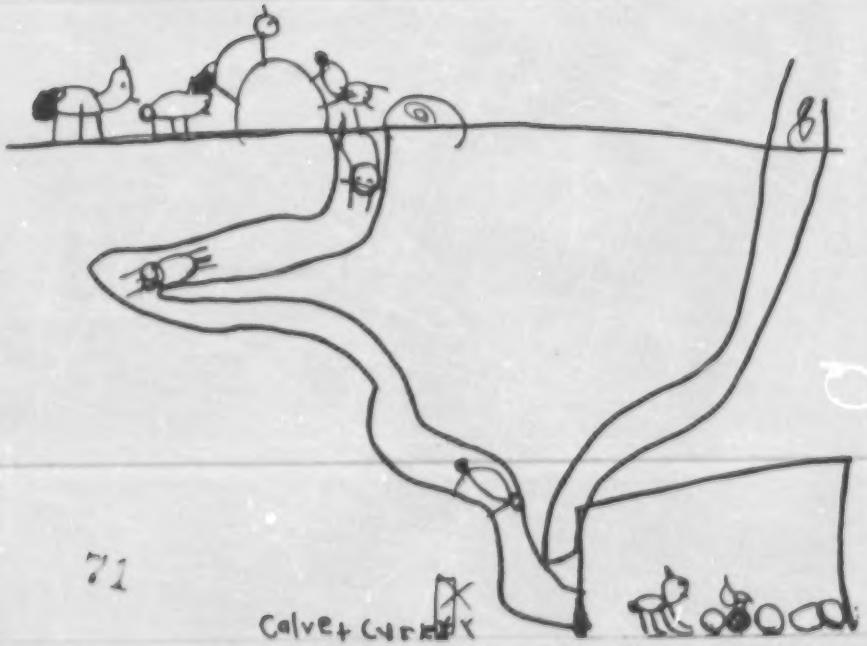
The students maintain their zoo until the end of the school year, adding animals as they are obtained. As the summer vacation approaches, the students discuss what to do with the animals. Those animals captured wild are released where they were found, and the other animals are given to certain members of the class.

After the Open House in the fall, one boy in the kindergarten class in Iowa City brought up the question of what to do with the toads during the winter. He was concerned that they be allowed to hibernate as they usually do. The children decided to let all their captured animals go. They released some near the school and some at their place of capture. (See log by Susan Marquis.)

6. QUESTIONS TO STIMULATE FURTHER INVESTIGATION AND ANALYSIS

- How can we find out more about the living things in the area around school?
- How could we make a zoo at school?
- What variety of animals do we want for our zoo?
- Are there any animals we couldn't keep in the classroom? Why?
- What do you need to know before you bring your animals into class?
- What materials should you use for your animal's container?
- What things would your animal like in its home?
- How could you find out which sort of home your animal prefers?
- What kind of food does your animal eat? How could you tell which kind it likes best?
- How can you be sure you leave enough food for your animal over the weekend?
- What could we do so that we don't have to keep buying/collecting food for our animals?
- Does your animal need extra warmth in the winter? How can you make its home warmer?
- How can we give our animals enough food/water/warmth over the vacation?
- How can you find out whether your animal likes people?
- How do animals react to others of the same kind in their cage? To other types of animals in their cage?
- Could any of our animals live together? Which ones? What sort of home would they need?
- How does your animal breathe? Do all our animals need air to survive?

- What does your animal do to have fun? What kinds of toys can you give it to play with?
- Does your animal "talk" to other animals? How do you think your animals communicate with each other?
- How could you find out whether your animal can tell colors apart? Does it like certain colors? Which ones?
- What are some of the most important differences between your animal and other animals around it?
- Could your animal survive outside? How would it protect itself? What food would it eat? Where would it live?
- What things would other children want to learn about your animals?
- What would be the best way to give other children information about your animals?
- What can we tell other children that would help them to set up a zoo?



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C. Documentation

1. LOG ON SCHOOL ZOO

by Susan Marquis*
Ernest Horn School (Kindergarten)
Iowa City, Iowa
(September-November 1974)

ABSTRACT

The children in this kindergarten class worked on the School Zoo challenge for two months, spending a short time each day during "free choice time." The challenge was introduced during a discussion of animals at a zoo and the kinds of homes provided for them. Children began building their own small zoo by bringing to class small amphibians and insects and housing them in available containers. Construction activities included making cardboard homes for insects. Students measured and weighed some of their animals and experimented to see which vegetable their guinea pigs liked best. The children also devised a fair method for distributing two litters of baby guinea pigs to children from other classes who wanted them. They made many observations about animal characteristics and behavior and, with help from the teacher, researched information from library books on their animals. In the culminating activity for the unit, the children prepared their zoo for the animal Open House for parents. They made signs for the Open House that identified the animals and told which ones could be handled, and they also prepared a tape on the care of guinea pigs to be played during the event.

My kindergarten class worked on the School Zoo challenge during "free choice time." This allowed a free in-and-out flow of groups for those with shorter attention spans, while other children could work for longer periods. Almost all of the children chose to do USMES for some of the time.

Originally, I had planned to start my zoo unit after the children had had some time to become accustomed to school and were, to some extent "socialized"--perhaps early October. However, during the workshop week before school opened,

*Edited by USMES staff

City Park offered free guinea pigs. It would have been great to go with the children to pick them up, but I had to "get them now or not at all." Consequently, our class began the year with two pregnant guinea pigs! Over the Labor Day weekend one of the guinea pigs gave birth to a litter of four, and two gerbils from the previous year returned from their summer vacation at a child's house. I decided that the time was right to start School Zoo.

I showed the class the SVE Picture-Story Study Print Set--Zoo Animals. This set of large color photographs included pictures of an elephant, chimpanzee, giraffe, hippopotamus, rhinoceros, tiger, and mountain goat. The children identified the animals, and I asked where you could go to see all of these animals ("the zoo"). "How many have been to a zoo?" (Everyone had, or thought they had.) I asked the children what kind of home they would provide for the mountain goat if they built a zoo. One boy said he would make a mountain out of wood, and paint it and then cover it with small rocks. We talked about the kinds of homes each of the seven animals in the photographs would need. I asked who would take care of the animals ("the zoo keeper"). "How many of you would like to be a zoo keeper?" Almost everyone did. The kids were very excited. We discussed the size of the animals in the pictures, and the children decided that they were too big, too wild, or too hard to find for keeping in a zoo at school. I asked them if we could make a little zoo in our school and what kind of animals we could keep in it. We made a list:

Guinea Pigs	Rabbit
Gerbils	Snake
People - "people are animals, too"	Dog
Frogs	Mice
Lightning Bugs	Toads
Squirrel	Goldfish
Butterflies and Caterpillars	Prairie Dog

The father of the girl who wanted to bring her dog for the zoo called me the following morning, and I had to reassure him that it was not my idea to have the dog at school. That day children brought in two grasshoppers, three caterpillars, and a toad. I added my ant farm which I had made at the USMES summer workshop, and we sat in a circle and passed the animals around for everyone to see. The animals the children had brought were temporarily housed in a jar, a coffee can, a margarine tub, and a bucket. I asked if

these were good homes for them, reminding the children of our discussion the previous day about making homes like the animals' natural environment.

Someone mentioned that it was difficult to see the grasshoppers in the coffee can. One boy, who had a plan for everything, suggested that we make a cage like the ones in a big zoo. He suggested that we glue "pencils without points on them" to blocks on the top and bottom; leaving little spaces behind the pencils. The people who had brought in the animals weren't satisfied with this solution.

The children were becoming restless; so I decided to move quickly into some activity. I asked what zoo keepers did for their animals, and we talked about care such as giving toys, food and water, cleaning cages, and making beds for the animals. I told the children that they could now have free choice time and that anyone who wanted to make animal homes or help care for the animals could meet me by the cages. About two-thirds of the class decided to come.

I reminded the group that a zoo keeper keeps cages clean. Were any of the cages dirty, I asked. The guinea pig cage was, but we decided that the babies and the expectant mother shouldn't be moved from the aquarium. How could we get the cedar chips out? Someone suggested a shovel, but we didn't have one. I asked if there was anything like a shovel we could use. A cup, someone replied. Five children retrieved cups from the playhouse and began cleaning the cage.

The toad was jumping wildly in its plastic-covered bucket. I asked what kind of home it needed. They decided it should be tall, and we walked around the room looking for a tall container. The group of three children discussed using the waste basket. One boy suggested "a real high box." I happened to know where there was one; we brought it back to the classroom and put the toad in it. The toad jumped but didn't come close to reaching the top of the box.

I asked the children if we needed anything else for the toad home? The children were puzzled. "What was the toad's home like outside where you caught him?" I asked the toad's captor. He said that the toad lived in grass and rocks, and we decided to go to the playground to find some. Most of the class came outside with us, and we quickly gathered what we needed and added it to the box. The children knew that the toad also needed water, and the boy who had found it filled his plastic bucket with water, set it in the box, and dropped the toad in. The toad jumped around frantically. I told him quickly to take the toad out. Some of the children knew that it was drowning because the bucket was too

Crystal Climbers: 2" square of plastic with notches in middle of each side.

Figure C1-1

deep. Someone brought a pan from the playhouse and the "owner" filled it with about an inch of water and set it in the box.

"What else will the toad need?" I asked. "Food," they replied. The children knew that it ate little insects, and so I asked the children where we could find out more about toads. After discussing this for a long time, they finally said "dictionaries and stuff," and a group of us went to the library to check out several books.

Meanwhile, another group of children had developed an ingenious see-through cover for the coffee can. They put together two sets of three Crystal Climbers (plastic building toys). This top allowed for visibility and air circulation (see Figure C1-1).

During the following weeks the zoo continued to grow. The first grasshoppers died, but the children brought in more. Two more toads were added to the toad box. The first toad seemed happier with company. One student brought in a new animal that the children felt was either a caterpillar or a snake. They asked whether they could look under the microscope to see if the animal had any legs because if it didn't, they would know it was a snake. When they looked under the microscope, they saw the little stubby legs of a caterpillar.

At the beginning of each USMES session, the class assembled to discuss new animals that had been brought in for the zoo. We would talk about the needs of the animals, and then the class would break into groups to get books from the library or to make a home for the animal. Later in the unit, when fewer animals were being added to the zoo, we listed what needed to be done in the way of care for the animals before the children broke into activity groups to work on their projects. The children were usually aware when a cage needed cleaning. "It's beginning to smell," they said.

Someone mentioned that the baby guinea pigs were getting big. I asked how we could be sure. The children wanted to put them on a scale. I found a postal scale, and they weighed the babies. I asked them how we could remember the weights later on. They told me to write down the colors of the guinea pigs, and then one girl wrote the number of ounces next to each.

Brown - 5
Black and Brown - 5
Black - 5

Mrs. Anderson 22

Mrs. Lopos 24

Mrs. Spaulding 28

Mrs. Wilkening 24

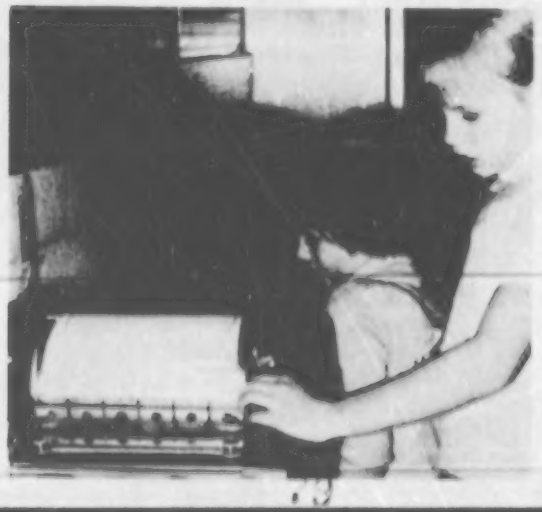
Mrs. Nelson 30

Mrs. Johnson 28

Miss Letizio 20

Mrs. Duncan 30

Figure C1-2



The children tried to weigh two toads by putting them on either end of a balance scale and adding weights to one side until the ends roughly balanced. (Since the student teacher had observed this, I didn't find out if this worked.) The following day, the children again weighed the guinea pigs. Two had stayed at five ounces but one had jumped to six. The students also tried to weigh the gerbils, but they would not stay on the scale.

During planning time at the beginning of an USMES period, I asked the children whether their animals needed naming. Many children had named their animals already. The guinea pigs were mentioned. Several children suggested names for one of them, which I wrote on the board. I asked how we could decide which name to choose. The children said: "Ask everyone." Each child in turn told me which name he/she liked, and I took the opportunity to give a skills session on tally marks. The winning name was "Taffy."

Our guinea pigs were now almost two weeks old. I reminded the children that they were old enough to leave their mother and asked how we could find good homes for them. Several children planned to ask their parents if they could have one. During the next session, one child suggested that they write notes to other children in the school. I told the children about some machines we have at school which save work by copying one note many times. I asked how we would know how many kids there were. "Count them," the children suggested. "What if they moved around too much and we miss some?" I asked. "We could ask the teachers," they said. We formed a committee which went around to the teachers and recorded the number of children in each class. (See Figure C1-2.) The class composed the note to the parents as a group. I took dictation and wrote the note on the chalkboard; one child volunteered to copy the note onto a piece of paper. The note the child wrote is shown in Figure C1-3.

When we had decided how many copies to make for each class, another group of children went into the workroom to run off the copies. We looked at the first name on the list and saw that we needed twenty-five copies. For each class, the children counted the number of copies as they came out of the machine and clipped them together for distribution. The children delivered the notes to the teachers before dismissal time. After the kindergarteners left in the afternoon, I was besieged by a mob of children from other classes wanting guinea pigs. In desperation I told the children that they needed a note from their parents and placed an entry box outside the door. The kindergarteners never

would You Like a baby Guinea Pig.
There Are only 3 OF them
You CAn Get them At ERNest Horn-
School
INthe KINDERGARTEN room FREE

Figure C1-3

questioned how the guinea pigs were distributed.

Before the baby guinea pigs left our zoo, I announced one morning that something special had happened. The children immediately guessed that the other guinea pig had given birth. We talked about how children should act around the cage so as not to disturb the five new ones. Someone mentioned that the mother had shrunk. Three children tried to count the total number of guinea pigs. The animals made it difficult by moving around a lot. Finally, one child said that there were nine or ten. The others seemed satisfied with this answer.

One child brought in a new caterpillar and immediately thought of going to the library to find books about caterpillars. After looking at pictures in the books, he decided that his caterpillar was a Monarch and needed milkweed leaves to eat. Another child discovered that one of the caterpillars was gone. On closer inspection, the class found a chrysalis. We talked about how caterpillars prepare to become butterflies. Towards the end of the period a lit-

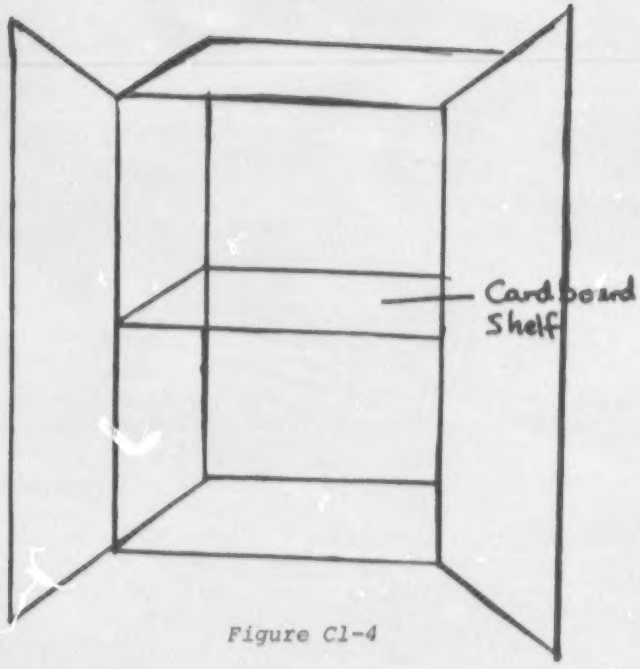


Figure C1-4

tle girl came up to me and said, "I brought a cocoon in that jar over there, but I think it's dead." I went to look and found a glass jar with a lid that had holes poked in it. Inside, on the bottom, was a hot green pepper!

During all the time the children handled the animals, I never noticed that anyone was afraid or repulsed by any of them, even when a grasshopper hopped out of a margarine tub onto someone's head. Whenever a new animal was brought in, the children spent a long time just watching it to see what it did. One caterpillar was brought in on a sprig of parsley and cooperated by eating the leaf while the children examined it. After looking at pictures they decided it was a Black Swallowtail. When they rubbed its head, orange horns appeared. They were thrilled with this discovery! The same caterpillar aroused interest by depositing round dark objects in its jar. The children wanted to look at them under the microscope, thinking that they might be eggs.*

After the children had examined each new find, they broke into activity groups to make homes for the new animals or to clean the existing cages. Before the first grasshoppers died, two boys made an elaborate home from corrugated cardboard furnished with grass and shredded paper. Another boy made a grasshopper home using corrugated cardboard, a roll of masking tape, and a sharp knife from the school kitchen. He cut several three-sided flaps on each side of the box. When he found an extra piece of cardboard inside the box, he made a visual size estimate, then cut it and taped it into the middle of the box to form a shelf. He explained that his grasshopper house had two stories. The flaps might be opened one at a time for observation. A diagram of the grasshopper home is shown in Figure C1-4. I noticed some cracks in the seams and asked whether the grasshopper could escape through them. He said that he thought not. (I disagreed but did not express an opinion.)

The children added water to their insect homes with an eyedropper and found out from library books that I read to them what the insects ate. A boy had brought in some ladybugs and a cricket; we read in a book that ladybugs eat insects and that crickets eat grain such as wheat. I asked him where we could get some wheat. He thought that the crackers that we have for snacks had wheat in them. After I had read aloud the ingredients on a cracker box to be sure that they had wheat in them, he broke off a small piece and added it to his jar. The cricket appeared to like it.

*The round, dark objects were droppings, not eggs. Only the adult (butterfly) lays eggs. --ED.

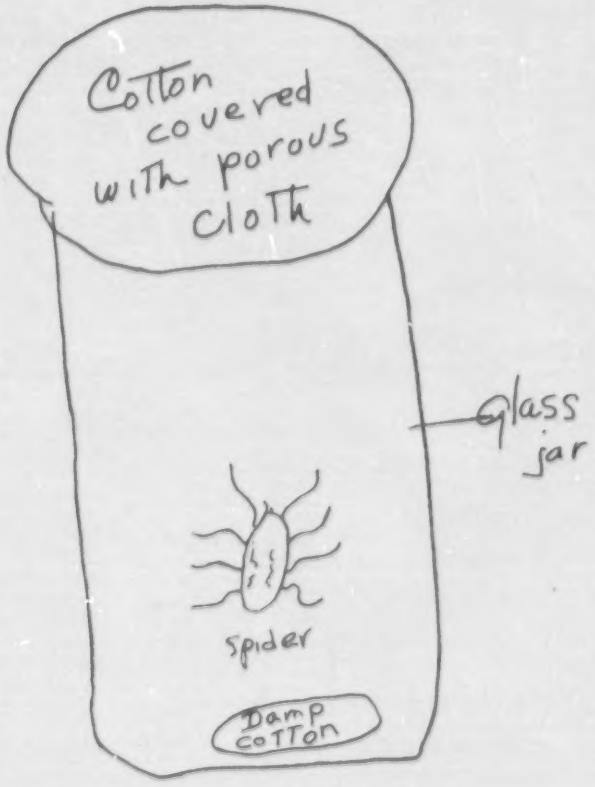


Figure C1-5

The children had become interested in informative books on their animals from our numerous excursions to the library. One morning, a boy brought in a book from home which had a chapter on grasshoppers. The boy explained how grasshoppers rub their legs on their wings to make a chirping sound. He showed the other children a diagram of a grasshopper from the book.

During "Show and Tell" one afternoon, a girl exhibited a huge spider in a margarine tub that she passed around for everyone to see. We discussed what we needed to find out about the spider. The children listed three things: (1) what kind of spider it is, (2) what kind of house it will need, and (3) what kind of food it will need. When I asked where we could find information on spiders, someone suggested an encyclopedia. Some of the children knew what this meant and described it as a large book from the library. One boy said we might check a "spider shop." The student teacher took part of the class to the library to look for books on spiders. When they returned the children looked at the pictures in a book they had found. They identified the spider as a "Golden Garden Spider" by comparing the picture with the markings on the spider. Meanwhile, I worked with another group to find a suitable home for the spider. The children agreed that the spider needed a home large enough to spin a web. They decided that it would also need water and "ants and bugs" for food. The children discussed how a spider catches bugs in its web and needs a home big enough to build a web. Our group came up with several options: a glass jar with holes in the lid, a shoe box, a house made of wood, and a tall can. The group with the book had read that a glass jar makes the best home and that only one spider should be put in a jar because "they eat each other." They also read that a damp cotton ball in the jar would give enough water. The book suggested putting gauze over the top of the jar. One boy constructed the home for the spider (see Figure C1-5), while the other children wandered off to spend time with the other animals. Although the book on spiders said that they can live eighteen months without food, the Golden Garden Spider died after a few weeks in our zoo.

A boy in our class brought in a snakeskin which he had reportedly found in his yard. He told us of his plans to try to find the snake which had left the skin. We had a discussion about the skin. The children knew that the snake had grown too big for its old skin. I asked if any of them had ever shed his or her skin. Many of the children laughed. "Why isn't it necessary for people to shed their skin?" I inquired. Many children volunteered the information that

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their skin gets bigger as they grow.*

One student brought a turtle that he had found into the classroom. The class discussed whether or not it was a snapping turtle and whether it could swim. The children put the turtle into the sink with a little water and watched it swim around. A group of children made a "diving platform" out of a glob of clay so that the turtle could crawl in and out of the water. Another group went to the library to find books on turtles. The children discussed the turtle's hard shell and its habit of drawing its legs and head in when it was frightened. They tried feeding the turtle some cooked hamburger meat but were not sure if the turtle ate it. During another session, the children discovered how to feed flies to the turtle. One student put his fingers over its nostrils. When the turtle opened its mouth to breathe, another student dropped in a dead fly. The turtle swallowed it. The turtle soon became conditioned to this routine and opened its mouth when its nostrils were just barely touched. If the children didn't get the fly into its mouth right away, it kept its mouth open for a while. When it felt the fly, it closed its mouth and swallowed. When questioned, the boys explained what had happened. "First, he couldn't breathe. Then he opened his mouth because he knew the fly was coming."

The children also discovered that the turtle liked to eat worms and that it disliked toads for company. When they put the turtle on a table with the toads next to it, the turtle retreated into its shell and wouldn't even come out when offered a worm.

The children who had brought in the three toads had names for them. The student teacher wrote the names on pieces of paper, and the children taped the labels to the toad box. The student teacher asked how they could tell which toad was which. The toads had conveniently come in three distinct sizes. One child thought of drawing pictures of the toads. He drew large toad, and other children eagerly volunteered to draw the other sizes. The children taped the pictures next to their names on the box.

One child brought a story book from home called Frog and Toad Together. In one story Frog makes cookies for the two. We talked about the difference between real and pretend. I asked the boy if he thought toads could dress up and cook. He said "no," but he still felt that toads eat cookies. We put a vanilla wafer in the toad box. The toads were unim-

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*Actually, people do shed portions of their skin daily; as individual skin cells die, they are sloughed off.--ED.

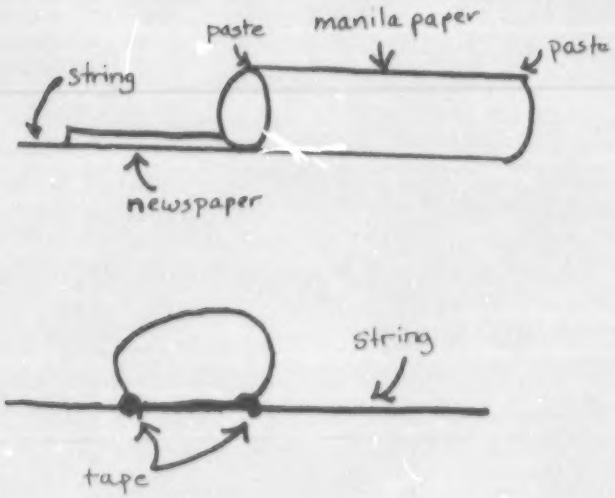


Figure C1-6

pressed; at the end of the period, the cookie was still there. The boy was not quite as sure that toads eat cookies.

I expressed my concern that the toads weren't getting enough to eat. Could we find a way to feed them live flies? The children suggested several kinds of nets and traps that could be made, and they broke into groups to solve this problem.

A group of three to four children attempted to make a trap by stacking two hollow blocks and standing by with a solid block to trap the fly when it went into the hollow ones. They spent most of one period moving the trap to different parts of the room in an unsuccessful effort to catch flies. Another group tried to make a net from string and masking tape. The holes between strings were about one inch square, through which any fly could have escaped; however, the quantity of tape used helped in reducing these holes considerably! One girl made a newspaper and string handle attached to a manila paper cylinder. She was so involved with the process that she gingerly sidestepped my questions of how she could prevent the fly from escaping out of the open ends of the cylinder. Another boy in the trap-making group used string and tape to make a fly lasso. As he explained it to me, the fly would go through the hole in the middle, and he would pull both ends of the string, thus trapping the fly. Some of the fly traps the children made are shown in Figure C1-6. I began to think that our toads would have a long wait!

During a later brainstorming session, a boy had another idea for catching flies: a venus fly trap! I asked how we could get the fly from the plant to the toad. He thought that we could just open the fly trap and take out the fly.

A workable fly trap was finally invented by lowering a margarine tub attached to a piece of string over a fly to catch it. (See Figure C1-7.) However, as far as I know, the children were never successful in getting a trapped fly to the toads. The best approach, they discovered, was to take the toad out of its cage and put it on a table six to eight inches from a fly. The toad scrunched down and sat very still. When the fly ventured closer, the toad lunged and ate it. The children were fascinated by the speed of the toad's tongue. "I bet you can't do that so fast," one boy challenged another. Later, the children discovered that toads would also eat dead flies that were floating in a pan of water. They swatted the flies, dropped them in water, and watched the toads cautiously stalk the floating objects.

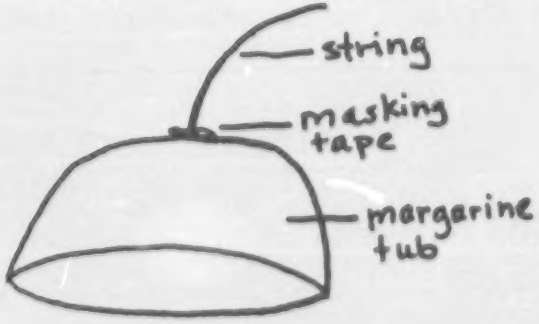


Figure C1-7

One girl brought to school a bag of lettuce and carrots

that she planned to feed the guinea pigs. I asked the whole class which of the vegetables the guinea pig would like best. Some children thought they'd like the lettuce; others, the carrots. I asked how we could tell for sure. This was a difficult problem for the kids to solve. Someone suggested that we feed them carrots first, then lettuce. I mentioned that the guinea pigs might be full after the first vegetable. Another student suggested that we vote. We talked about whether this would tell which vegetable the guinea pigs liked, or which we thought they liked. Finally, one girl suggested putting both lettuce and carrots on the table and seeing which the guinea pigs ate first. This sounded reasonable to everyone. We tried the experiment, and both guinea pigs ate the carrots. I asked how we could remember the results. One student wrote "Taffy" and "Pebbles" on a sheet of paper, and another drew pictures of carrots under the names of the animals. (See Figure C1-8). The following day, the children repeated the experiment. This time, "Taffy" again chose a carrot, but "Pebbles" took lettuce. I asked the children why this happened. They suggested that (1) the carrots that I'd brought weren't as good and (2) "Pebbles" was tired of carrots.

At the beginning of one USMES period, I asked why animals are sometimes taken out of their cages in a regular zoo. Various people offered suggestions: (1) to let the animals see the world, (2) to clean the cages, (3) to feed them outside their cages. I asked the children how they would feel if they were confined to the same small space all the time. The children all agreed that they wouldn't like it. "What would you feel like doing once you were out of that space?" I asked. They said that they would like to "run around." I inquired whether it would be good for animals to get exercise, too. There was considerable discussion. Children said that if the animals were let out of the room, they might get lost or stepped on.

The children finally decided that some animals could be exercised in the gym. They decided to take one set at a time. The class took the seven guinea pigs to the gym in empty toy trays. The children had a hard time keeping their hands off the animals; they wanted to prod them to get them moving. One boy brought some carrots and served them to the guinea pigs on the gym floor. The children counted the animals; no one had difficulty reaching seven. A couple of boys matter-of-factly picked up the guinea pig droppings from the gym floor with paper towels. Most of the children watched the guinea pigs in the gym until the end of the session.

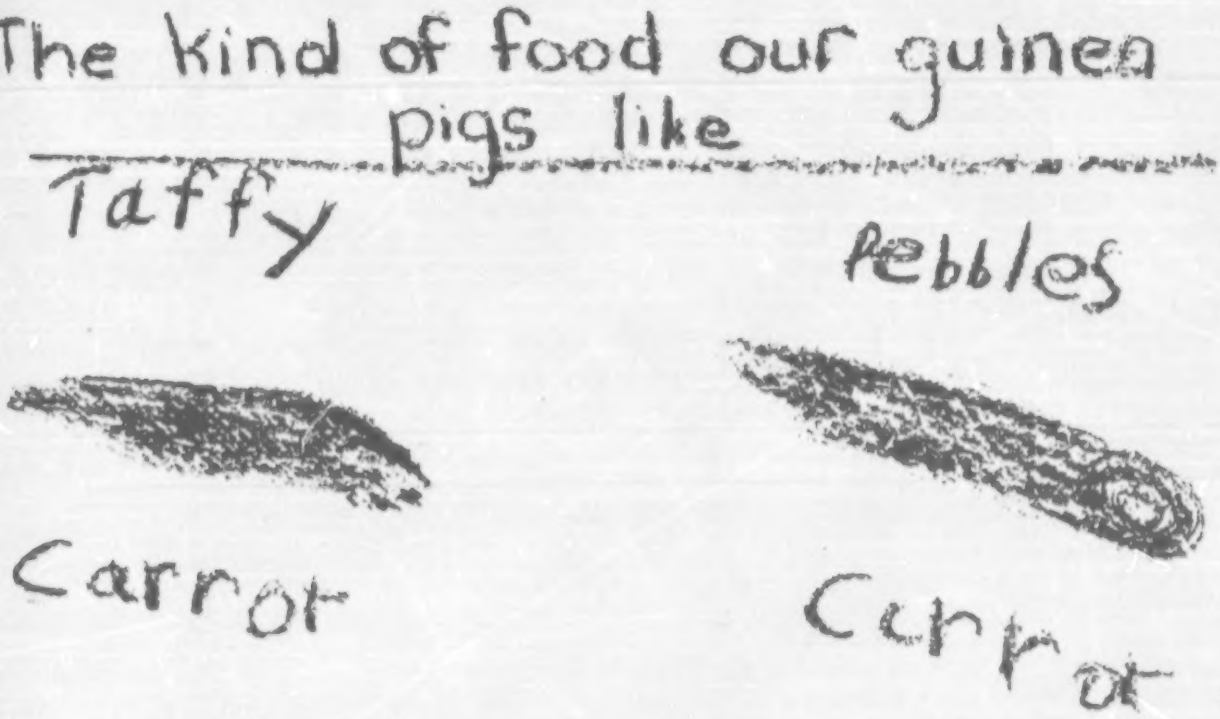


Figure C1-8

Again, it was time to think about finding new homes for young guinea pigs. This time the children were reluctant to give them away because there were no new ones to take their place. I talked about the expense of feeding seven guinea pigs, but the economic element of the discussion was pure disaster! The children had no concept of paying for food. Then, one boy suggested that we could give the guinea pigs away. I was afraid that we would never come to this point! Another boy suggested a compromise--give all the "boys" away. I asked how we could tell which were "boys." One child said

we could check to see if they had nipples. We looked, but all the guinea pigs had them. After consulting a book, we discovered how to press the guinea pigs' stomachs to check their sex. We had two males and three females. The terms "male" and "female" were new to the children. As it turned out, "Flint," the most popular of the babies, was a male. The children liked him because he had brown and white spots while the others were all brown. After further discussion and a vote, we decided to give all the baby guinea pigs away except Flint.

Previously, the kindergarteners had not been involved in the final selection of guinea pig winners. Since we had nine notes left over from the last time, I wanted to make sure that they helped to pick the people receiving the four guinea pigs. The children thought that there were not enough guinea pigs to go around. To be sure, I handed out four pencils which I asked them to pretend were guinea pigs and to match them one to one with the notes. They agreed that there were not enough. The children managed to track down five of the nine children who wanted guinea pigs and asked them if they wanted to share with other people who wanted one. No one wanted to share, nor did they feel it was practical. How could we solve the problem? Finally, a boy suggested: "We could choose four notes." He suggested putting them all on the floor and picking four. We spread them on the floor, he chose one note and three other people each chose another note. The children located three of the winners on the playground; no one knew the other person. How could we find him/her? The children immediately thought of going to the librarian, whom they regarded as the keeper of all knowledge. One of the aides in the library knew the boy, and we wrote a note saying "You have won a guinea pig" and gave it to his teacher.

General discussion at the beginning of one USMES period near the end of October focused on finding a better home for the turtle. Children suggested finding an aquarium or building a wooden container in the Design Lab, but they were concerned about the wood getting soggy from the water. The group finally decided to move the guinea pigs out of their aquarium and into a box and to put the turtle in the aquarium. They chose the guinea pigs rather than the gerbils, because they knew that gerbils might chew their way out of a cardboard box. I asked how we could find out whether the aquarium was waterproof. Eleven boys volunteered for a committee. They agreed to split into groups to do different tasks. The cedar chips and the guinea pigs were transferred

to a cardboard carton, and six boys began testing the aquarium for leaks. Then they had the problem of getting the water out again. They ladled it out until it reached a certain level, then used large sponges to absorb the last bit. The question was raised about which sponge took up the most water. They wrung the sponges into a jar and measured the water level. When all the water had been soaked up, they mopped out the aquarium with paper towels.

On October 28 and 29, the annual fall Open House for parents visiting their children's classrooms took place. I reminded the kindergarteners that many people would be in the classroom to see the zoo. This event was a perfect focus for the School Zoo unit. I had been afraid that the unit would fade out, as it seemed difficult for the kids to see at any point that they had reached a solution to the challenge.* The Open House provided a time reference in which to work, as well as a more definite goal.

The class discussed what people coming to the Open House might want to know about the animals in the zoo. We made a list on the board of the things the class could tell people:

1. How to feed the animals
2. How to take care of them
3. How to clean the cages
4. How many animals we have
5. How many inches the toads are (three boys had measured them and wanted to be sure to include this information--see Figure C1-9).

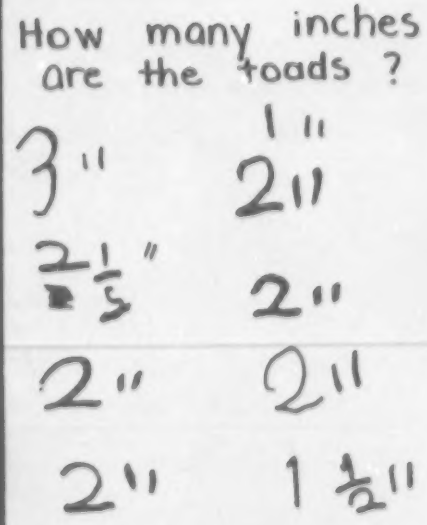


Figure C1-9

Someone suggested that we could make a tape recording to tell people about the guinea pigs. A group of three boys got together to discuss the tape and decided to have me take dictation so that they could remember everything to say. The children listed three things that they thought people should know: (1) how to feed the guinea pigs, (2) how to clean the cages, and (3) how to pick them up so as not to hurt them. In order to record the information, I read an item, the tape was started, and one of the children repeated what I had said. On the next page is a transcript of the tape:

*The "teaching others" aspect of the challenge was subsequently made more obvious by substituting the words "help your class and others learn about them" for the words "as a learning resource."--ED.

How to Take Care of Guinea Pigs

How to feed them.

- Put food in their bowl.
- When the bottle's empty, put more water in it.
- They eat lettuce, carrots, dry guinea pig pellets, cucumbers, tomatoes, celery, apples.
- They need a salt lick.

How to clean their cage.

- Get a cup that is metal and dig out the stuff.
- Wash the bowl.
- Wash the bottom of the cage.
- Put down newspaper.
- Put wood chips on the newspaper.
- Put a box in the cage so they can hide.

How to pick them up.

- Hold them with both hands.
- Sit on a chair when you hold them.
- Be gentle.
- Don't leave them out when you're not playing with them.

The tape was played for parents during the Open House nights.

The group counting the animals first named all the kinds of animals in the zoo:

Guinea Pigs
Turtle
Gerbils
Toads
Ants
Grasshoppers
Spider
Caterpillars
Daddy Long Legs
Snails.

Each person in the group then picked one kind of animal, counted how many there were, and returned to record the number next to its name on a list. The list we made is shown in Figure C1-10. Later, the children recounted the

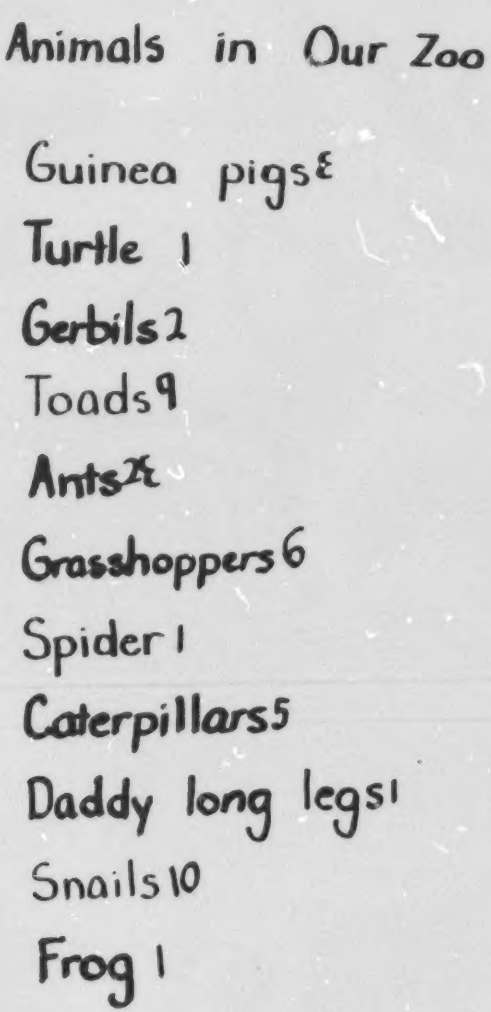


Figure C1-13

animals because a few had been added and several insects and the Golden Garden Spider had died. I asked the children how they could tell if an animal were dead or not. "If it doesn't move," they said. But they were not fooled by the cocoons, which they knew should turn into butterflies in the spring.

I asked the class what would happen if people wanted to pick up an animal during the Open House. They were concerned because they felt that people might get bitten or scratched if they didn't know how to handle an animal or that they might injure one of the animals or let it escape. They were especially concerned about one of the guinea pigs which had been weak after weaning its young. They made a list of animals which could not be picked up:

Taffy (the guinea pig)
Grasshoppers
Ants
Spider
Caterpillar
Daddy Long Legs.

They made another list of animals which could be handled:

All of the Toads
Pebbles and Flint (guinea pigs)
Snails
Turtle.

After some discussion about whether the gerbils would get loose if people picked them up, they decided to add them to the second list.

Our next question was how to let people know not to touch some of the animals. We discussed all the possibilities, including handing out notes, telling people at the door, writing the information on the board, and putting signs on the cages. Then we voted; the results were as follows: Notes-6, Signs-10, Tell-2, and Chalkboard-1. I wrote down the information they wanted to include on the signs, such as "Don't touch the ants," and they copied it on slips of paper and taped them to the cages. One child drew pictures of the guinea pigs so that people could tell which one could be handled and which one could not. (One guinea pig was brown and white, the other was black and white.)

The day of the Open House, a boy brought in a small frog which he had found in a puddle behind his house. Someone

suggested that it might be a tree frog. Another child said that we could go to the library to find a book on frogs. (The children had become much more accustomed to going to the library to look up information in books; I no longer had to ask questions to get them to think of doing research.) I went with seven children and the frog to the library. The librarian found us a book about North American frogs with colored illustrations. The children compared the illustrations with their frog. When they found a picture that resembled the frog, I read them the description to see if it fit. At last we found a picture and description that matched our frog; it was a "Little Grass Frog." The book did not show that it was found in Iowa, but we found no other kind that even came close to matching our frog.

We returned to the classroom to solve the frog housing problem. Since the toads were living in cardboard boxes, a box seemed the ideal home for the frog. The children had noticed that the frog was a good jumper. I asked how tall the sides of the box had to be so that the frog could not jump out. The owner of the frog got a ruler and put the frog at one end. The frog jumped to the three inch mark. The boy repeated the experiment several times, while other children excitedly watched. The children finally decided that the box must be taller than eight inches. We went into the hall to check the available boxes. The children decided on one that was 11½" high. They covered the inside with grass and added a pan of water and the frog. The boy labeled the box with one sign that read "Little Grass Frog" and another that said "Timmy", the name he had given it. Two mornings later, after the Open House, my student teacher and I discovered that Timothy had escaped. He was never found, although we all looked for him.

The Open House was a big success. For two nights the zoo was visited by parents, including many families with no kindergarten children. Elsewhere in the room were other displays of the children's activities, but I think that most of the families spent at least half of their time at the zoo. The kindergarteners came with their families to show them around the zoo.

After the Open House, a parent brought in a large aquarium which the children decided to use as a home for the male guinea pig. A group of children figured out how to remove the dirt caked at the bottom by adding water to softer it. Then they scrubbed it with a sponge and added cedar chips to make a home for "Flint".

It had been a rainy week. One morning two boys brought

in a large supply of worms. As usual, the toads would not touch them but the turtle did. It took all my self-control not to say "ick" or "bleck", but the children were never offended by the worm-eating habits of the turtle. I noticed that children of this age don't seem bothered by the idea of animals eating each other; they accept the food chain better than many adults do. However, they can be very compassionate on seeing a picture of a wounded or sick animal. I had also noticed that they became increasingly more gentle handling the animals as they grew more and more attached to them. One girl even had a habit of kissing her toad, an act which many adults would find offensive.

After the Open House, we had a social studies lesson on Animals in Winter (Holt, Rinehart & Winston: Databank, Level K). I also read a library book to the children on hibernation.

The class discussed what to do with the animals in the zoo that usually hibernate during the winter. I brought up the problem of feeding them, since the fly and earthworm supply was becoming increasingly smaller. One student felt very strongly that it wouldn't be fair to "take animals' lives away." After the discussion, we voted on whether to release the animals. Sixteen of the eighteen class members were in favor of releasing them. We talked about where to let them go--near the school where we could find them in the spring or at the place where they had been found? It was finally decided that the people who had caught the animals would decide where to let them go. Six toads were released near the school; three toads and the turtle went home to be released at their place of capture. The children eagerly looked forward to spring, "when the toads come out again."

2. MINI-LOG ON SCHOOL ZOO
Guinea Pigs

by Judith White*
Adams School, Grade 1
Lexington, Massachusetts
(September 1973-June 1974)

ABSTRACT

The children in this first-grade class worked on School Zoo for several hours a week during the 1973-1974 school year. They investigated two types of animals, guinea pigs (included here) and crayfish, and began by discussing the needs of two pet guinea pigs in the classroom and ways to improve the animals' "environment" by providing more comfortable bedding and a toy for them. The children cleaned the guinea pigs' cage regularly and conducted a food preference test to see whether they preferred celery, lettuce, or carrots. The children wrote several "experience" stories about the guinea pigs and, with help from the teachers, put together a book on care of guinea pigs called All About Guinea Pigs. Each child in the class illustrated his/her own copy of the guinea pig book. Illustrations from the best two books were used in a slide/tape show on how to clean a guinea pig cage. The children made their own audiotape by reading the script aloud. At the end of the school year, the children presented the slide/tape show to other first-grade classes.

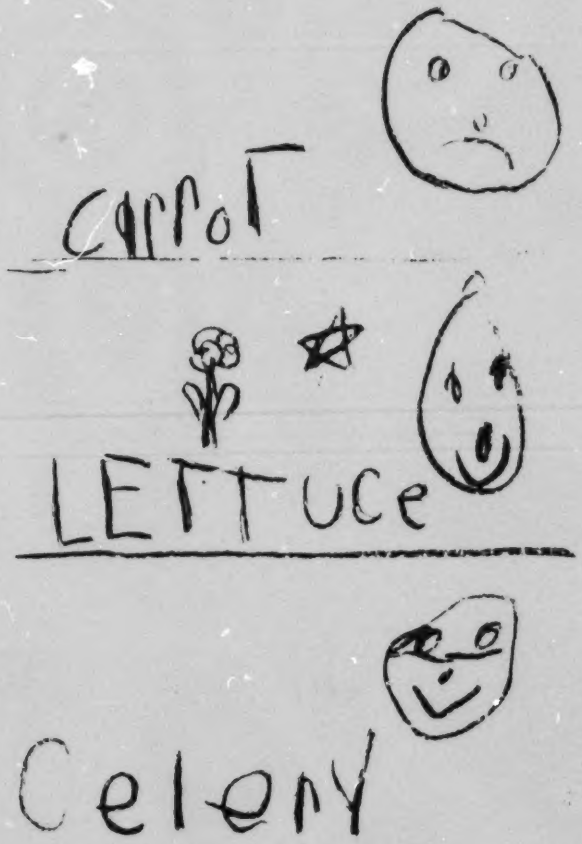


Figure C2-1

My students began discussing the needs of the two guinea pigs that we had in the classroom. They quickly decided that food, water, care, a clean cage, and company were necessary. The students then decided that they had adequately provided for the guinea pigs, except for bedding. They promptly cleaned the cage and put in hay for bedding.

After observing the guinea pigs for several weeks, the children experimented to discover their preferences for food. Placing celery, carrots, and lettuce in separate piles on the floor, the students then placed the guinea pigs in front of each of the piles in turn. They liked the celery and ate the lettuce but wouldn't touch the carrots. The children recorded these results on the chart reproduced in Figure C2-1. They further decided that the guinea pigs preferred green, leafy, juicy vegetables and that these should be used for their food.

*Edited by USMES staff

The class decided that they wanted to find out how the guinea pigs behaved outside. When placed on a grassy area, the guinea pigs moved around and ate grass and leaves. Placed on the paved area, they stayed still and didn't move. The children recorded their observations in the experience story shown below.

October 17, 1973

Guinea Pig Action

We took the guinea pigs outside. We made a circle around them in the grass. They ate grass and leaves. They really ate. They moved around. The guinea pigs liked the grass because they like to eat it because it is sweet and soft. Then we switched from the grass to the cement. They didn't move around that much. So we got a pile of leaves and they crawled over and ate them. Then we took them in the school.

The End.

Later, I asked the class whether they would be interested in making books about our guinea pigs, and they were very enthusiastic about the idea. One student suggested illustrating the books by placing a guinea pig on its side and tracing around it, but the class vetoed this suggestion. We discussed a math book that we could make with equations, addition, and subtraction sets and a science wildlife book about weighing and measuring guinea pigs. When I asked what guinea pigs needed, the class responded, "food and water," and agreed that these should go in a "Care" book. The children also suggested a book on how to clean guinea pig cages and how to build a cage. However, the class decided not to write about building a cage because they had never made a cage and didn't know much about it.

I asked the class what they would do first while working on their books. Some of the students said that they would think of a title, then think of the story, the words, and illustrations. The class divided into groups, each group to work on a different book. Each group had a recorder to take suggestions. One group's work is shown in Figure C2-2.

At the next session one member of the class suggested that perhaps we should just write one great big book with everyone helping. The class decided that they could write a book called *All About Guinea Pigs*. They decided that this should be the main title and then they suggested various

How to clean a guinea pig cage

1. get news papper
2. empty the cage
3. put the hay in
4. take the guinea pigs out
5 get some food
6 get some water

Figure C2-2

subtitles: "How to Clean a Guinea Pig's Cage," "How to Care for Guinea Pigs," "How to Weigh and Size Guinea Pigs." One child asked whether guinea pigs were rodents, and we borrowed a book from another class to find out. When this didn't help, we decided to look up "rodent" in the dictionary. After sounding out and spelling the word, they found it in the dictionary. It defined a rodent as any gnawing animal with a short tail. The children objected, noting that guinea pigs don't have tails, and I had to find another book which said that guinea pigs were rodents.

We then decided to start with the section, "How to Clean a Guinea Pig's Cage." The class members called out different sentences and I wrote them down:

Open the cage.
Take out the guinea pigs.
Take off the top before you dump the trash.
Put newspaper on the bottom of the cage.
Put hay or wood chips, not potato chips, over the newspaper.
If it is hay, pack it down...put the guinea pigs in.
Put the top on, and then you have cleaned the cage.

I suggested that the class follow the steps in the booklet to see whether they had a clean cage. I reread the steps in the story as they carried them out. We discovered that they hadn't said what to do with the guinea pigs when they were taken out of the cage. The class decided the best idea was to take them out and play with them. The class then decided it took four people to clean the guinea pig cage: two to look after the guinea pigs while two cleaned the cage. The children also decided to add what to do with the trash.

I typed each sentence onto a page and duplicated the pages. Each child was given a booklet to illustrate. Page 1 of one booklet is shown in Figure C2-3. We decided to place several copies of the booklet in the school library to be signed out by other classes.

Next we worked on the booklet, "How to Care for Guinea Pigs." The children decided that they should start the book by describing what it was about. The story they wrote and illustrated in the booklet is shown below.

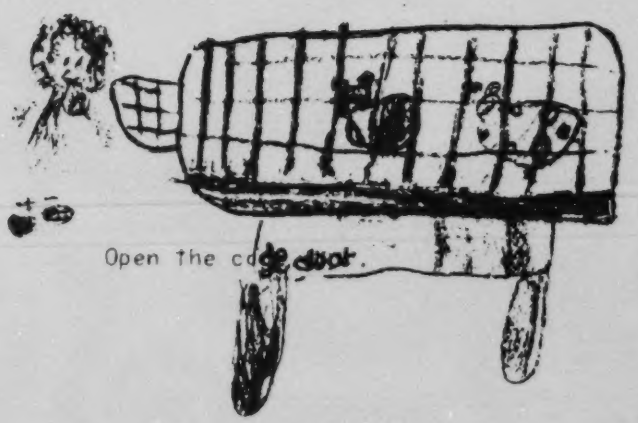
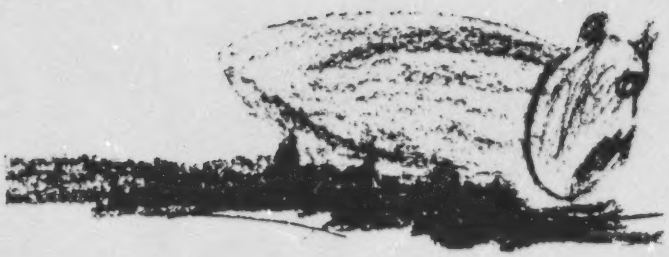


Figure C2-3



Guinea pigs are rodents without tails.

Figure C2-4

How to Care for Guinea Pigs

This book is about how to care for guinea pigs.
Guinea pigs are rodents without tails.
Clean their cage twice a week.
They eat carrots, lettuce, cabbage, apples, pellets, celery and paper.
Do not make a cage out of paper or they'll eat it and escape.
They drink water.
You need to love them by petting and not hating them.
Do not kiss them or you might get germs.
And that's how you care for guinea pigs.

The children typed the story themselves on the primary typewriter, each sentence on a new page. When we had duplicated it, the children illustrated the pages. Page 2 of this booklet is shown in Figure C2-4.

We then composed the text for a third book (shown below). However, we did not have time to duplicate and illustrate this book.

How to Weigh and Size a Guinea Pig

This story is about how to weigh and size a guinea pig.
You need a balance scale that has two bowls.
You put one guinea pig in one bowl and the other guinea pig in the other bowl.
The bowl that is lower has the heavier guinea pig in it.
You could use a yardstick or a ruler for measuring guinea pigs.
You put the guinea pig along the side of the ruler or yardstick to see how many inches it is.

Near the end of the school year the class decided to make a slide/tape show for the other first-grade classes on how to clean a guinea pig cage. We took apart the two best booklets to use the drawings for the slides, and other students drew extra paintings.

We photographed the paintings and, while the slides were being developed, worked on the audiotape to go with them. I encouraged everyone to take part, and all the students practiced reading one of the sentences aloud. When we had chosen the speakers, one for each sentence, we recorded the script. Our first recording had too much background noise and some of the students read too fast. We decided to practice the script and then repeat the taping.

When the slides were returned, they came as a film strip, and the students cut them up to put into individual slide holders. The children were really delighted with the slides.

It took two more sessions to complete the recording of the script. We then presented the slide/tape show to the other first-grade classes at the end of the school year.

3. LOG ON SCHOOL ZOO

by Marion Twaites*
Vista View School, Grade 4
Burnsville, Minnesota
(September 1974-April 1975)

ABSTRACT

The children in this class (half of whom were in second-grade level reading groups) were very interested in animals and eager to start their own zoo. They worked on the challenge for most of the year and spent an average of three forty-five minute sessions each week. In the fall the children collected animals in the area around the school, but as the weather turned colder, they bought fish and other animals with their own money. Some animals were housed in cages and aquaria purchased by the children, others in modified pickle jars, and still others in cages made by the children in the Design Lab. The children also wrote brief logs each day about what they had done. When the groups of children had their animals comfortably housed, they made plans for several investigations. These took the form of experiments to find the animal's food or color preferences, races and training the animals to run mazes or perform tricks. When the class made plans to open the zoo to visitors during the spring fair, the children decided to postpone the remainder of their experiments and keep the zoo at a maintenance level until a month before the proposed open house. In the last month the children worked hard improving cages, building mazes, training their animals, and making charts and posters about them. They organized all the details of their exhibit themselves, and it was a great success.

During the first two weeks of school the class talked about animals several times, and one girl brought her pet rabbit to school for a day. When the children were showing a lot of interest in animals, I brought in my two gerbils and my hamster and we all sat around discussing our experiences with these animals. This led to further discussions about experiences with all kinds of animals. The children were very excited by these exchanges of stories and at the next session they were eager to discuss animals again. I asked them what kinds of animals would be good to keep in the classroom, and they immediately suggested the gerbils

*Edited by USMES staff.

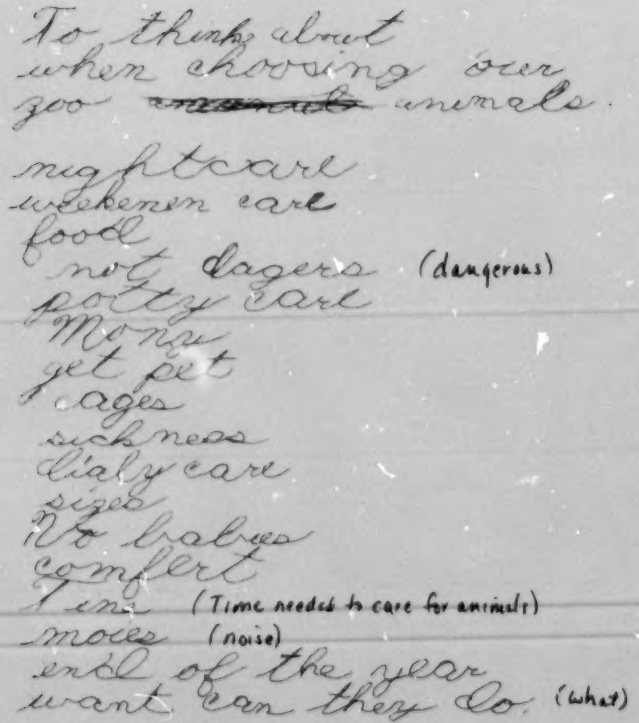


Figure C3-1

and hamster. The next idea was a snake. This provoked some discussion because a snake had escaped from the kindergarten room last year. The children decided that the cage would have to be strong and that the snake should be non-poisonous. Another animal mentioned was a dog, and this instigated some thoughtful comments. At first the children thought that this would be fun, but as the discussion progressed, more and more problems were foreseen. The class finally decided that a dog was too big and bothersome to be kept in a classroom.

One boy suddenly suggested that we make a list of things to think about when we decide on animals for the classroom. This idea was well-received, and someone else quickly volunteered to write the list on the board. The children were very sensible about making their list and discussed each point carefully. A child's copy of the list is shown in Figure C3-1.

The children were worried about whether or not they would have enough money to buy the animals and feed them. When they had finished their lists, I suggested that we look around outside to find animals that were available without spending money. The children thought that this was a good idea and divided into small groups to search the school grounds for animals. After fifteen minutes of careful searching--turning over rocks and leaves and examining plants--the children came back with long lists of animals that they had seen. These included butterflies, ticks, crickets, bees, spiders, squirrels, and birds. The children were impressed with the great variety of animals around. One girl suggested that we also look at a nearby pond, and we arranged to take a field trip there the following week.

At this point I asked the children what would be the point of keeping all these animals in our room, and what we could learn from it. Their answers left no doubt that they felt they could learn a lot about the animals, how to take care of them, how to help them, and how to make cages for them. One student suggested, "We could let other kids in to see our animals and tell them all about them just like the guys at the Zoo." As the children had arrived at the challenge themselves, I had only to repeat it to them: "Do you really want to build up our very own school zoo?" The answer was a resounding, "Yes!"

Our field trip to the pond was very successful, and the children again recorded all the animals they saw. As they had discussed things to consider before bringing animals into class, no one tried to collect animals before we were

ready for them. Most of the animals seen were insects, but a couple of snakes were spotted, too. One boy, Tony, found some interesting caterpillars which he decided to bring to the classroom and watch. A few older children decided what animal they wanted to keep, while others were still undecided.

Tony was so keen on his project that he had plans for a caterpillar house ready to show me by the next lesson. Two other boys decided to help him with it, and accompanied by the student teacher, they went off to a spare room where I had set up a few tools and materials (our Design Lab wasn't ready yet). Tony had drawn a diagram of each side, the top, and the bottom of the cage and had stapled them all together. They used a ruler and a marker to mark the correct size for the top, 10" x 7 3/4", on wire mesh. When they had cut out the top, they compared it to the front side to be sure the pieces would fit together before they cut out the sides. The cage was much admired when they returned to the classroom with three sides cut out. Unfortunately Tony moved away a few weeks later, but he donated his completed cage to one of his helpers.

Older children began forming groups and choosing animals with which to work. They used resource books that I had borrowed from the media center and the public library to help them. The animals chosen by the children included guppies, turtles, snakes, worms, caterpillars, frogs, and goldfish. Some children started to draw plans for containers for their animals and to list materials that they would need. Rick and John made the following list of materials for their frog cage:

screen
wire
glass
water
sand
little bits of grass
wood
little rock

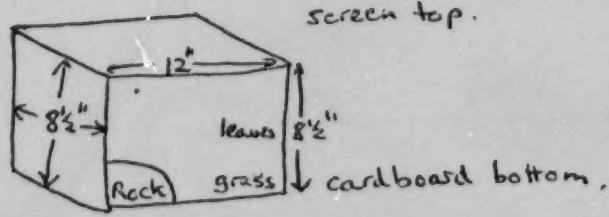


Figure C3-2

A diagram of Cindy's caterpillar cage similar to the one she drew is shown in Figure C3-2.

By the next session two more boys were ready to use our improvised Design Lab to make wooden supports to stop a jar put on its side from rolling. Three children started making catching nets for guppies, and others went to the kitchen

to scrounge large jars. The rest of the class continued choosing animals, making plans, and listing supplies needed.

The first animals started appearing the next day. A group of girls housed two fish in a large commercial-sized jar and began learning how to dechlorinate water, and one boy brought some crickets into class. During the next month most of the children acquired an animal and a home for it, and some started investigations to find out more about their animals.

One boy made a cage for grasshoppers out of wire mesh, bound together with wire at the corners, and soldered in a few places. After a few days he discovered that some of the grasshoppers had escaped, and he had to repair the gaps in the cage by lacing them with wire. He made a chart to record how many babies his grasshoppers had in the spring, and planned to see how high each animal could jump. Unfortunately, all the grasshoppers died one weekend. He thought that this was either because he didn't spray the cage with water, or because it got too cold with the heating off over the weekend.*

A group of three girls started with two fish in a large pickle jar. One of the girls took the fish home over the weekend so that she could enjoy them at home, too, and decided not to bring them back to school. The group did some research on grasshoppers and then became interested in fish again. They planned what supplies they would need for goldfish, including a tank, filter, and bubbler, and they also considered getting a catfish to keep the tank clean. When the goldfish were purchased, the girls planned to investigate what effect colored lights had on the fish.

A group of two boys started making a home for a frog in a commercial-sized pickle jar. However, one of the boys brought a bruised frog to school in a small cardboard box before the container was ready. The other children in the class took pity on the frog and persuaded the boy to let it go. Since frogs became scarce because of the cold fall, the boys' interest in frogs waned and they bought some goldfish. They tried an experiment to find out how much the goldfish would eat in five minutes, but two of their three fish died of overfeeding before this was established.

Two girls started working independently on cages for worms. Their plans involved putting two sheets of glass close together with dirt and the worms between them. Both

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*Another possibility is that the grasshoppers would have died at this time of year anyway. The children might try to find a book on the life cycle of grasshoppers.--ED.

girls had difficulty cutting the glass to size and constructing the cages. One girl, Heather, was told by her father that it was too difficult for her, so she kept her worms in a large jar half-filled with dirt. She tried to race her worms but discovered that they do not move in a straight line. Unfortunately, after a few weeks she overwatered the dirt and the worms died.

The other girl, Molly, abandoned altogether the idea of keeping worms and instead kept goldfish in a large glass jar. She and Heather worked together to find out how much the fish would eat. With the cold fall, animals were becoming very scarce outside, and most children began purchasing animals with their own money.

One boy planned to keep a snake, and built an elaborate cage at home with his father's help. When the cage was ready, he couldn't find any snakes, and instead he bought five chameleons. The chameleons were kept in a small aquarium inside the snake cage and had a lightbulb for warmth, a thermometer, a humidity gauge, plastic plants, and a dish of water. Although the boy put a lock on the cage to protect his animals and attached a list of rules to the side, he was generous about letting other children handle the chameleons. They were very popular with other children in the class, who were particularly interested in their ability to change color. The boy observed that the chameleons were brown in the cage but green outside "cause it's cooler." They turned gray when it was too cold or when they "didn't feel good." He planned to make a chart to show how much the chameleons ate each day. He also began to construct mazes for them.

One girl began working with a caterpillar in a coffee can, but when the caterpillar died for lack of water, she kept crickets in a restaurant jar. She put dirt on the bottom, sprinkled hamster litter on top "to keep it clean," and added gerbil seed, a bottle cap full of water, and a crumpled paper towel. She did a lot of research on crickets and made a list of the following information to put on her cage:

1. A leaping orthopterous insect. Having long antenna. The male makes the chirping sound by friction of the fore wings.
2. They are vegetarian.
3. They like grain because of that. They destroy farmers crops.
4. They eat holes in material.
5. In Japan they are considered good luck.
6. We are trying different foods to see which they will eat:

Bugs - No
Grass - No
Leaves - No
Cereal (Oatmeal) - ?
Weeds (seed) - ?
Bread - ?
Seeds - ?
Gerbil Crunch (cornmeal) - yes

Other animals that were brought in were a salamander housed in an ice cream pail with dirt and weeds, more grasshoppers, and a baby hamster. The salamander did not live long, possibly because his home was too dry.

I asked the children to write logs at the end of each lesson so that they could remember what they had done and I could keep track of all the different groups. At first their logs were very short, but they improved with practice. Two examples of early logs are given below:

> Chris, Oct. 9th: Me and Cindy have been planning how we are going to cut our wire for the cage.
>
> Matt and Rick, Oct. 16th: We are trying to remember our food and animals. We are reading about fish.

During this period of setting up our zoo we had an Open House for parents after school. The children were very proud to be able to show their work to their parents, though some of the parents weren't very eager to touch the animals.

When some of the children wanted to start investigations with their animals, I gave small group skill sessions on graphing and handed out duplicated sheets to supplement the "How To" Cards. The children had not done any graphing before and seemed interested in the idea. Most of the children were too impatient to keep careful records, however, as they wanted to get on and work with their animals. Much of our USMES time was spent cleaning the cages and feeding the animals, and the children also got a lot of enjoyment from cuddling and playing with their animals.

At this point I discussed the possibility of making a joint display with a teacher whose class was working on the USMES unit "Growing Plants." Our principal suggested that we both put on displays during the school-wide Art Fair in the spring. I passed this suggestion on to the class, reminding them of their earlier decision to make their zoo available to other children. They were very enthusiastic

about the idea and eagerly went to work, their goal redefined.

Many children began devising experiments that they could do with their animals. During one class session I called the students together and we made a chart on the board of some of the experiments that were being planned. The children enjoyed seeing their activities on a chart. A copy of the chart is shown below.

Person	Animal	Possible Experiments
Mike B. Jeff	hamster	dark and light preference
Molly Heather	goldfish	food
Cindy	cricket	jumping
Mike K. Steve	chameleons	maze
Curt John	goldfish	food
Mark	guinea pig	tricks and amount of food
Cindy N. Sharon	goldfish	going through hoop
Dawn Theresa	goldfish	colored lights
Brenda Kris	gerbil (Ger)	food choice, wheel, tricks
Rick Scott	gerbil (Bill)	stair and maze
Matt Marc	rat (Slurp)	climb ladder and go in jar
Brad Kevin	rat (Burp)	jump over pencil

In addition, eight children showed interest in bringing wild birds to our zoo by hanging bird feeders outside our windows. Four of the children brought bird feeders that they had made at home. These are illustrated in Figure C3-3.

We asked the custodian about drilling holes in the outside brick to run wires across each of our windows. The custodian thought that he should do this himself, and we had the wires ready the same day. We had some problems hanging the feeders, however. One made from popsicle sticks was unstable, and it fell off the wire and broke. The girl who had made it repaired the feeder and decided to hang it from

Bird Feeders

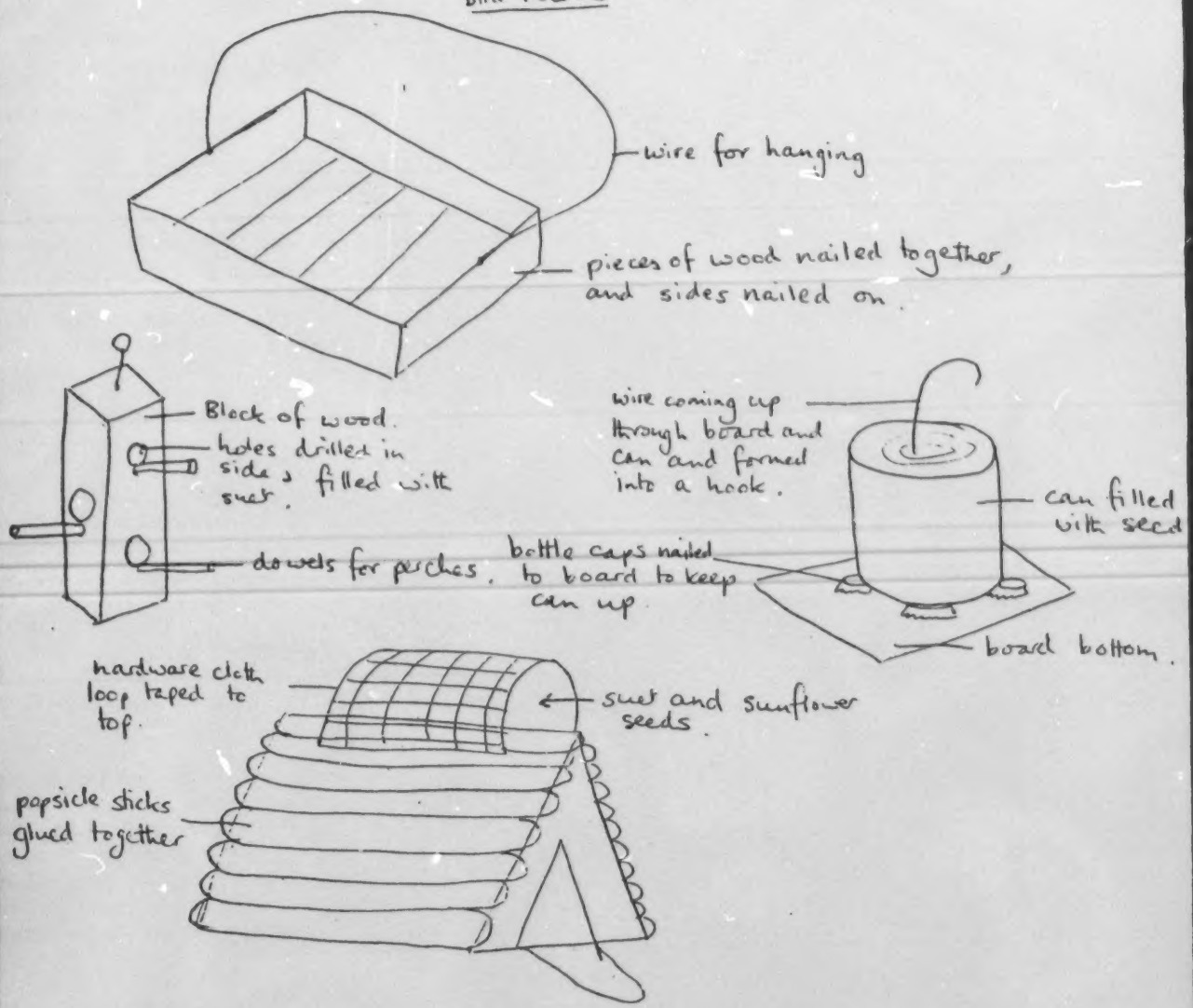

wire for hanging
pieces of wood nailed together, and sides nailed on.
Block of wood.
holes drilled in side, filled with suet.
dowels for perches.
wire coming up through board and can and formed into a hook.
can filled with seed
bottle caps nailed to board to keep can up
board bottom.
hardware cloth loop taped to top.
suet and sunflower seeds.
popsicle sticks glued together

Figure C3-3

a nearby tree. This was probably a better idea since we had some trouble attracting birds to the feeders. One boy suggested laying a trail of sunflower seeds from a flock of birds he had seen in the yard to our feeders, but no one tried out this suggestion.

Throughout November the children continued to work on their animal experiments. Some of the experiments were not too well thought out and did not provide useful information but many of them were interesting and taught the children something about animal behavior. For instance, the children learned that some animals, such as rats, are much easier to teach than others, such as fish or chameleons. (Experiments with different animals are described below.)

One girl tried to train her goldfish to go through a hoop when she whistled. When it did perform correctly, she rewarded it with a bit of fish food. However, she had to give up when she discovered that the fish was a slow learner and did not behave consistently. She kept records of all her observations in her daily logs. Two examples are given below:

> Cindy, Nov. 20: Today I named my fish Sholts (the skinny one) and Arnold (the fat one). I whistled and I took the hoop and went around and around a few times. Now I am going to buy some wire for a new hoop. And now the fish are getting the idea of going through the hoop, but Arnold thinks that he's not supposed to go through the hoop so I'm going to ask my mom if I can buy a bigger tank because the tank is too small for the fish are getting bigger.
>
> Nov. 21st: Today me and Heather worked on the fish and we found out that the fish can't hear people whistle so we put the food in front of the hoop so now they are going through the hoop. Also Arnold is getting fatter and Sholts is getting skinnier so I have a problem. We are getting a fish tank because the fish are getting bigger and fatter.

Two groups working with goldfish added food coloring to the water and observed the reactions of the fish to see

which color they preferred.* Curt and John tested the fish in red and green colored water and reported: "They like red better than green, because in red they're calm and in green they swim around." Heather and Molly added green, red, and brown food coloring and had the following results with each:

Green: Fish are nervous, open their mouths a lot, and wiggle.
Red: Fish did same as in green, but not as much.
Brown: Fish stayed together and at top of tank and liked it lots better.

Another goldfish group tried to find out if their fish preferred to be in the light or in the dark. They darkened one part of the tank with a cardboard box and watched where the fish went. The children noticed that the fish swam in the corner which was darkest and concluded that fish like dark better.

Several of the children working with guinea pigs tried experiments to see what kind of food they preferred.** The most successful experiment is documented in one boy's log which appears below:

> Richard, Nov. 25: We did an experiment. We got lettuce and apples and pellets. We put some of these things in both sides of the cage and we wanted to see what kind of food he would eat. He went to one side of the cage and he ate all the lettuce. He ate all of it and so we found that guinea pig liked the lettuce.

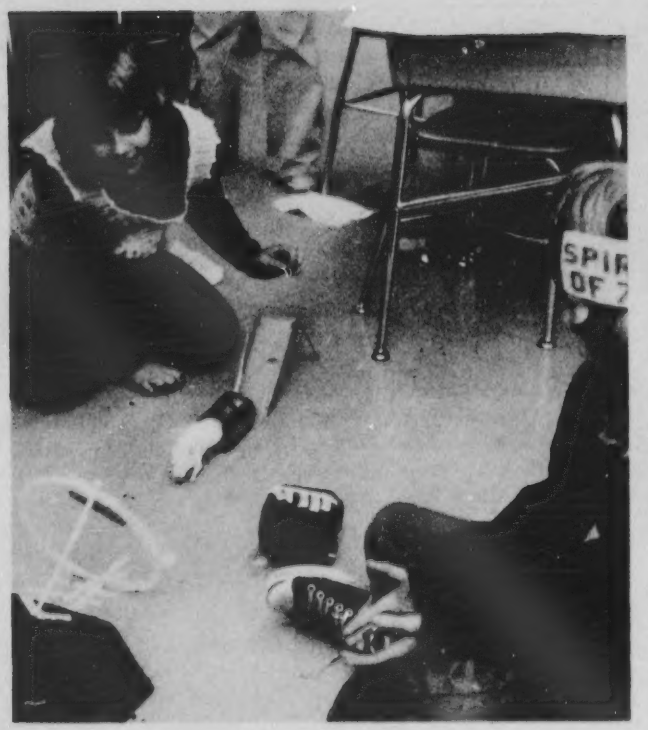
*The children might try taping sheets of colored acetate to the sides of the aquarium.

**During the maintenance period the children could keep a record of the amount of water the animals drink each day, the amount and type of food they eat, frequency of cage cleaning, etc. The data can be used in making booklets on the care of the animals. It can also be used to calculate the amount of food to be collected, how often a water bottle needs to be refilled, how often water has to be added to an aquarium, etc.

The children can also keep records on the size, length, or weight of their animals. Graphs showing growth over a period of several months can be constructed later. Children can compare the growth rates for several animals by making slope diagrams.--ED.

The group working with chameleons tried to construct a maze for them, but they were not successful at teaching them how to run in it. However, they did figure out a way to race the chameleons. When they put them at the bottom of a large flannel-board held vertically, they found that the chameleons would run quickly toward the top. Here is one boy's record of one of the races:

> Mike K., Nov. 21: Lewey vs. Hewey. Winner was Lewey. He sat and he zoomed way up and Hewey laid there. Lewey moved more and he won.



The chameleon races were very popular with the other children. A chameleon named Henry seemed to be quicker than the others and won most of the races.

Two boys taught one of the rats to go up a small ladder, down a slide, and into a jar. The children were quite proud of their accomplishment and were amazed at the rat's intelligence. Another group of boys started constructing a gerbil maze but did not complete it.

We had two tragedies during this time. Molly put her goldfish in with a large snail she had been given, and the fish died in about two minutes. There was a lot of discussion about what could have caused this sudden death. The fish were buried in the yard. Also one of our gerbils got very thin and began losing hair, and despite all our efforts with doses of vitamins it died. We had a class discussion about the cycle of nature, and the class decided to bury the gerbil in the yard in a cardboard box that would decompose. We talked about how the gerbil would slowly change into a part of the soil to help other things grow.

The children felt better about the death of the gerbil when three baby guinea pigs were born the same day. They felt that the cycle of life had been completed by having births follow a death.

After the Thanksgiving vacation when the animals were taken home, the class realized that all the special events leading up to Christmas were going to take up a lot of their time. We decided to leave our experiments for the time being and to keep the zoo just at a maintenance level until the beginning of March. At that time we planned to start preparing a presentation for the school fair to be held at the beginning of April.

During the maintenance period we had a calendar posted showing who would be looking after the two gerbils and two rats which were our class animals. Two children had the job for three days at a time. Usually the children remembered

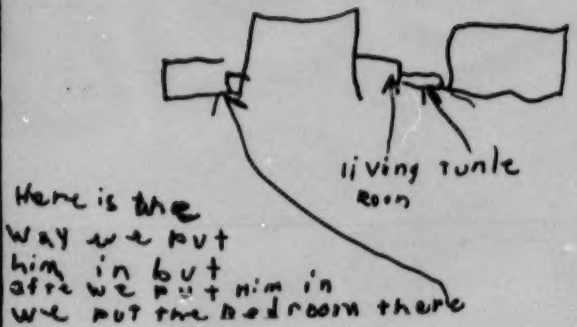


Figure C3-4

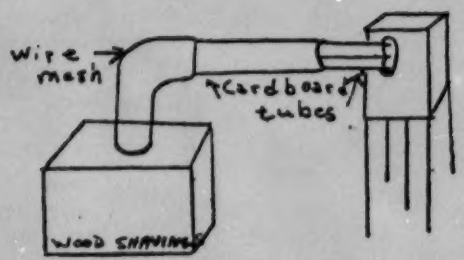


Figure C3-5

their chores, and, if not, they were helped out by children looking after the privately-owned animals. Even though we were not working with the animals, interest in them was still high, and the children played with them at every opportunity.

Quite a few children had made plans for their animals in preparation for our return to USMES activities. The children were very eager to get going again and were excited by the prospect of making a display for the school fair. We started by listing all the animals in our zoo and who was working with each animal. This was necessary because some of the children had switched animals and also because we had several new additions to the zoo: three mice, a hamster and three goldfish. Our list came to twenty-one animals, twenty-five children and me! We decided that the guinea pig that had been given to the class needed a bigger cage, and we discussed the possibility of enclosing the zoo area of our room. By now our zoo had taken over one whole end of the classroom.

The children wanted to put on a good display for the school fair, and most wanted to do this by having their animal perform a trick. Much of our preparation time was therefore spent training the animals as we had been doing before Christmas. The children who had been working on the gerbil maze before Christmas finished it for the Open House. Their maze had rooms as well as tunnels. A sketch of the maze made by one of the children appears in Figure C3-4.

The children built more complicated mazes for hamsters, other gerbils, and guinea pigs. They also built tunnels and elaborate homes for several of the animals and improved existing homes for others by painting them and building additions.

The boys working with chameleons made houses out of cardboard box lids taped together with shutters on the doors to control the light. They put the chameleons inside so that they could "run around and stuff, inside."

The children working with the hamster made a "three-way apartment" consisting of a box with legs and a wire mesh tube which connected the box to a covered aquarium. (See Figure C3-5.) They taught the hamster to hang by its legs from a stick. Another trick they tried was to place the hamster in a plastic exercise ball. As the hamster ran, the ball rolled along.

The children working with two guinea pigs made a maze out of a row of boxes taped together with holes on the sides for air. They put food in some of the boxes to encourage the guinea pigs to go through the maze. The children timed how

March 4.
We are making
like a hous
we need a
box then we
cut a door
for Bupp to
go in the we
are going to
make a ladder
so Bupp can
climb up to
the roof cause
we are cutting
a square so
Bupp can look
out.
KRISTIE

Figure C3-6

long it took the guinea pigs to run the maze and found the best time to be about two seconds.

The rat group made a house for one of the rats with a ladder coming out from the top. A log of one boy in this group which documents this activity is shown in Figure C3-6.

With just a week to go we gathered for a discussion of our schedule up to the school fair. Things that had to be completed were listed:

1. outside bulletin board
2. hallway direction signs
3. individual charts of experiments
4. individual knowledge charts
5. room layout and demonstration times
6. zoo beautification

The last week passed very quickly in a flurry of activity. Cages and mazes were finished and reports on animals such as the one below were written out as posters.

Chameleon's Reports

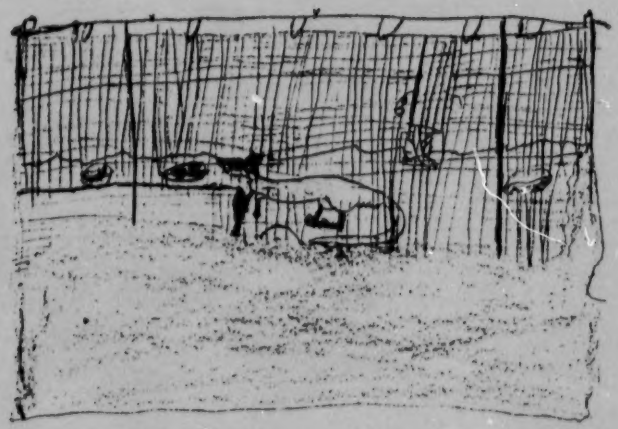
Chameleons are lizards, but they have a family of their own. They turn grey when they're sick. Chameleons eat bugs such as mealworms, flys, spiders. They even eat black widow spiders. They become very tame. They will stay on anyone's shirt. They'll sit on your hand if it is warm. Chameleons are hard to train. It's easy to teach their names.

Some children also drew pictures of their animals, such as the one shown in Figure C3-7.

The children were worried about tiring the animals at the fair, but they wanted to be sure that there was always something for the visitors to see. One boy volunteered to plan a schedule for demonstrating the animals throughout the fair. He tried to get a variety of animals at each time. His schedule is shown in Figure C3-8.

One girl volunteered to find out how much room everyone needed for their display. She then planned a layout for the room so that people could walk through and see everything. As we were going to use the whole room for the zoo, we had abandoned our idea of enclosing the zoo area. The floor plan she drew up is shown in Figure C3-9. On the day before the fair we had a trial of this layout. We found it

Brad W.



The name of The rat [redacted] Birp

Figure C3-7

SCIENCE FAIR ZOO SCHEDULE

1-1:30
Molly (hamster Peppy)
Cindy + Valie (guinea pig-Cinnamon)
Rick + Scott (Bill the gerbil)
Matt + Marc (mouse-Speedy)
Mike K + Steve (chameleons)

7:30-8
Mike B + Jeff (hamsters)
Mark + Theresa (guinea pigs (Charlette + Speedy)
Kris + Richard
Dawn Brenda + sharon (rats - Burp + Slurp)

8-8:30
Cindy A + Heather (hamster - Fluffy)
Carl + John (guinea pig - Fritz)
Kevin (mouse mousie)
Brad + Mike W (gerbils Bonnie + Cladel

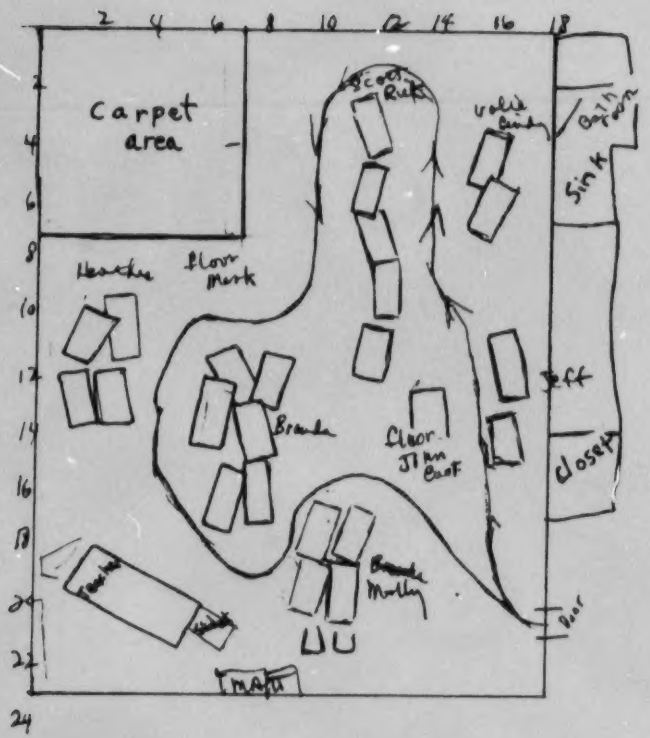
Figure C3-8

didn't allow for very easy traffic flow; so we modified it by moving a few desks. Two girls decided to tape arrows to the floor to help show the path the visitors should follow.

Many advertising posters were made inviting people to come to the ZOOROOM, such as the one shown in Figure C3-10, and they were posted around the school on the morning before the fair. We also put a portable bulletin board across the hallway to help direct people to our room. There was a burst of feverish activity: cleaning the cages, grooming the animals, arranging the room, and making everything neat and tidy; then we were ready.

The fair was very well attended and the ZOOROOM particularly so. Not only parents of our zoo keepers but also complete strangers stood in a line that stretched fifty feet from our doorway to see our zoo. They asked the children questions and seemed genuinely interested in their responses. Most seemed very impressed and told the children so.

In the lesson after the fair the children expressed their pride in themselves and their delight with the success of the unit. When I asked them what they liked and didn't like about USMES, they had many positive comments. The only negative comment was: "The only bad thing is that an USMES unit has to come to an end sometime."



2 ft = 1 square

[illegible] = 1 desk

Figure C3-9

Hi. I'M BURP the RAt!

I'm inviting you to come to a zooparade there are all sorts of animals like: RATS MICE HAMSTERS GERBILS GUINEA PIGS TOO.

here's direction's: go on the bottem floor turn left go on till you get to 106 repeat 106

APRIL 8th

COME ON IN!

Figure C3-10

4. LOG ON SCHOOL ZOO

by Cynthia Wychocki*
Horace Mann School, Grade 5
Chicago, Illinois
(September 1974-May 1975)

ABSTRACT

Students in this fifth-grade class worked two to five days a week on School Zoo, averaging approximately five hours per week. They began talking about bringing animals into the classroom in September. After a class discussion the children decided to hold a bake sale to raise money to buy animals, food, and materials for making cages. Most of the animals were purchased in pet stores, and the children divided into groups and made elaborate plans for housing them in cages. Cage construction was slow until the Design Lab opened in midyear, but the children did manage to build some things in the classroom with materials which they bought or scrounged. The children also observed their animals and kept careful watch on their habits. Various groups devised simple experiments and kept records to see what foods the animals preferred, how much they ate or drank, and how they reacted to new environments, objects, and other animals. When animals occasionally escaped, the children were very ingenious about finding ways to recapture them. Children working with different animals also read about their animals in library books and made reports on their readings and observations. In the spring the class had an Open House for other classes in the school. They prepared reports, charts, posters, and oral presentations on the various animals in the zoo. To advertise the Open House, a group of students put on a "radio show" over the intercom system during which they read stories and poems and sang songs that they had written. The children received many compliments on the show and the Open House was well received by most of the visiting classes.

On the first day of school the children in my class began discussing the idea of collecting animals and keeping them in the classroom. This idea apparently arose because we had an empty aquarium and cage in the room. I asked the children what their idea of a school zoo would be. Their comments included—

"Why can't we let the animals run around?"

"Can I bring my pet monkey from home?"

*Edited by USMES staff

"Can we have a turtle?"
"How about an elephant?"
"I have bees at my house. I can bring some in a jar."
"We can go out and catch butterflies!"
"How can we keep them in our room all year?"
"I hope our pets have babies."
"Where are we going to put these animals?"

At our first meeting we discussed how we could raise money to start a zoo. Suggestions for fund-raising activities included "a bake sale," "a raffle," "a bookfair," and "collecting money from each child."

After this initial enthusiastic discussion, I issued this challenge to the class: Find animals that you would like as pets, bring them to school, and raise them in our classroom for the school year. The children left for home that day with great enthusiasm.

In a later class discussion the students made a list of the materials needed to house the animals that they planned to keep. They decided that they would need to raise money not only for food and housing but also to buy many of the animals. The next day they made plans for holding a bake sale the following week to which they would invite the other fifth grades. The children made a list of what each child would make for the sale. Part of the class broke into groups to make signs for advertising the sale. They decided that the following information should be included on their signs: time of the sale, date, place, cost, and pictures of baked goods. In later sessions some of the children wrote messages to be read in the classes invited to the sale; others rearranged the room for the sale.

The bake sale was a big success. The class made $56.49 from the goods that had been baked. After the sale the children discussed what they needed to buy with this money and made the following list of animals and materials:

bird and cage	food
gerbils	wire
rabbits	wood
guinea pigs	hammer
fish	nails
water bottles	white mice
ant farm	

Meanwhile, several animals were added to the zoo. The children brought a butterfly and a grasshopper (which subsequently died). Three girls added a total of six fish to

the zoo. Two hamsters were brought in, but one created havoc for a few days by escaping into the heater soon after its arrival. (The children never discovered how it got out of its cage.) A few days later, someone came to clean the heater and found the hamster inside, hungry and thirsty. Two girls coaxed it out with sunflower seeds.

During the weekend following the bake sale I ran across a one-day sale on rabbits, gerbils, and guinea pigs at a pet store. I purchased a rabbit, two gerbils, and a guinea pig with the class money and brought them to school on Monday. The children were tremendously excited and immediately set to work finding houses other than cardboard boxes for the new members of the zoo. They housed the rabbit in a wire milk box, the gerbils in an aquarium converted into a cage with chicken wire over the top, and the guinea pig in an empty cage in the room.

Each type of animal had a group of children caring for it. One group of students who did not yet have a pet to care for wrote a story about the School Zoo to be published in the school newsletter. The story explained the class activities and added a plea for donations of old cages, aquaria, wood, wire, and tools to our cause. They also offered a 25¢ award to anyone donating an animal to the zoo.

When the newsletter was circulated, we received several new animals from other children in the school. One child brought four baby frogs and one small toad, and two boys volunteered to care for them. They found a small aquarium, filled the bottom with dirt, and added a few large rocks and three cups of water. A child from another class donated a garden snake, which one boy chose to care for. The only home he could find for the snake was a large coffee can with a lid. The mother of a first-grade child read the newsletter story and brought in a huge turtle.

One boy who had previously shown little interest in School Zoo was excited by the challenge of feeding and housing the turtle. He carefully cleaned the garbage can, placed the turtle inside, and then found to his surprise that his animal was too large for the can! He left the turtle in a large cardboard box over the weekend.

Once the children had found temporary homes for their animals, they began researching information on their needs for food and space. Every day each group worked either on cage construction, library research on animal needs, cleaning cages and feeding their animals, or observing the behavior of their animal and its interaction with other animals.

The group working with hamsters found that one of their

135

pets seemed not to like being held or fondled. Although they didn't know what sex the two hamsters were, some of the children discussed mating them. The group observed how hamsters can store large amounts of food in their pouches. Some of the girls tried to train the hamsters to "stand tall" to receive a raisin or a sunflower seed; however, they had trouble with other students eating the raisins brought for the hamsters.

The gerbil group spent much of their time observing their animals, which they discovered were very active during the day. They set up rolls of paper and tried to "train" their pets to walk through them. When they put a gerbil and a hamster in a cage together, a fight ensued, but neither animal was injured.

Children in the rabbit group learned in one day that rabbits need more room than a milk crate and that they are very messy and eat and drink a lot. They needed to feed the rabbit twice a day. Some children in the group brought wood, a hammer, and nails from home. They began making a new cage for the rabbit. While they were working in the classroom (we had no Design Lab then), the rabbit was hopping around. The group heard a strange gnawing noise and discovered that the rabbit was chewing on the wood to be used for his cage. They quickly decided that they would need to build the cage from some material other than wood, and they redesigned their plans for the cage. The group spent most of one USMES period cleaning up after the rabbit. They began calling it a "vacuum cleaner" because it ate everything around.

The fish group decided to put all six fish inside an aquarium rather than keep them in individual bowls. They placed the tank on a stand, arranged plants and gravel in the bottom, and carried buckets of water from the girls' washroom to the tank. They decided to let the water set a few days before adding the fish. During the next session they put the fish in the tank and started the pump. They had trouble keeping the filter going. One student also cracked the plastic clasp that held the heater in position. Over the weekend, water evaporated from the tank, causing the pump to stop. When they got it working again, they had difficulty making the suction right.

Other children joined the boy caring for the turtle. The group read in library books that turtles eat small water animals and vegetables. They felt that it was a cross be-

tween a snapping turtle and a large land turtle.* The children put various objects in front of the turtle to see if it responded, but it did not snap at them.

One of the boys in the group wrote a report on "Tuffy the Turtle" and included the following information:

1. Turtle's shell is made up of many overlapping scales.
2. His shell is not easy to tear apart.
3. His shell is made of calcium.
4. He does not have outside ears, but he can hear well.
5. He eats lettuce, frogs, carrots, and other vegetables.
6. He has webbed feet.
7. He can hold his breath for a long time.

A few days later the group found the turtle dead. Children in the group felt that he had died of old age. In the afternoon of the same day, a boy brought a box turtle for the group to care for. The turtle group examined their new turtle and noticed his small size and his ability to pull his head in and close up his shell in front to protect it. The group decided to keep this turtle in a grape crate until they could build him a new cage. They used newspaper as temporary bedding.

One girl in the class wanted to buy "sea monkeys" (brine shrimp) and raise them, but the other students discouraged her because they had discovered from prior experience that this type of animal was difficult to keep alive. When someone brought in two crayfish to add to the zoo, the class agreed to give them to the girl. She made some initial observations of the crayfish and housed them in an empty bowl. The bowl had to be cleaned frequently because the water became dirty and smelly. The crayfish subsequently died over our first vacation because they were not properly cared for.**

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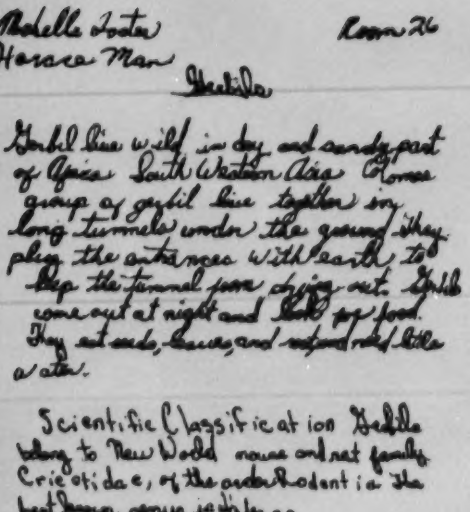
*The children might look in a field guide for reptiles and amphibians to find out the group to which the turtle belonged. There is no such "cross" as they described, since "snapping turtle" and "land turtle" species do not interbreed.--ED.

**The children might discuss the natural surroundings of crayfish and try to set up a similar environment with rocks and shallow water.--ED.


Rochelle Foster Room 26
Horace Mann
Gerbils

Gerbil like wild in dry and sandy part of Africa South Western Asia Homes groups of gerbil live together in long tunnels under the ground they plug the entrances with earth to keep the tunnel pure dying out. Gerbil come out at night and look for food. They eat seeds, leaves, and insects and little water.

Scientific Classification Gerbils belong to New World mouse and rat family Cricetidae, of the order Rodentia the best known genus is Gerbilus

Figure C4-1

Another huge toad was brought in and added to the toad and frog collection. It was so large that it squashed one of the small frogs. The group held a race to measure which of the frogs or toads jumped the highest and the farthest. The children did not have much luck keeping toads and frogs --they died when the weather grew colder.*

The children made notes on the day-to-day progress of their animal(s) and wrote reports from the information they found in library books. They kept their logs and reports in an USMES folder. An example of one of their reports is shown in Figure C4-1.

During one session we discussed the question, "What is a living thing?" We talked about differences between vertebrates and invertebrates and classified animals as amphibian, fish, reptile, bird, or mammal. The children decided to find out more about their animals. Most of the class broke into groups; they listed ways to tell whether their pets were living or not and whether they were vertebrate or invertebrate, and they classified them according to animal group. We met as a class to share the results of our observations. The children decided to add this information to their folders and to use it for making signs about the animals when the zoo was opened to the school. I felt that this discussion used USMES very successfully to illustrate science concepts.

The children used library books on animals and other resources to learn from their mistakes. The hamster group decided to house their hamsters together in the belief that they were friends. Two weeks later, one killed the other in a fight. They read in a book that adult hamsters cannot live together in one cage. After the hamster's death, they believed what they had read. A few days later, one of the gerbils also died. When the gerbil group examined the body, they agreed that he was not killed by the other gerbil. They then remembered that when the gerbils had been purchased, the clerk at the pet shop had said not to put cedar bedding in the cage because gerbils are allergic to it. The group admitted that they had run out of pine bedding and had borrowed cedar chips from the hamster group.

*Children who want to work with cold-blooded animals such as toads and turtles should research the needs of these animals as soon as they acquire them. Classes lacking information on food, warmth, and moisture requirements for these animals may not be able to keep them alive during the winter months. See bibliography in Section D for possible sources.--ED.

The children used the following books for information on their pets:

Your Aquarium by Sylvan Cohen, M.D.
Fish Facts - book about fish
Your First Aquarium by Sigmund J. Albert
Frogs and Toads by Herbert S. Zine
Junior Science Book of Turtles by Henry Hill Collins
How and Why Wonder Book of Reptiles by R. Mathewson
Enjoy Your Guinea Pig by Earl Schneider

During the course of the unit, our class was faced with many problems that needed to be solved. Some of our major difficulties included what to do with the animals over vacations, how to find a constant food supply, how to keep the room clean, and how to get the Design Lab going so that the children could work on cage construction.

A few weeks before Thanksgiving we held a class discussion to determine what to do with the animals over the long weekend. One person in each group volunteered to take their animal(s) home. The students brought permission slips from home and assigned each animal a place to visit. The day before the animals were to be taken home, the children cleaned their animals' cages thoroughly so that their parents would not know how messy they were. Two girls brought in old hair brushes which they used to brush the rabbit and the guinea pig so that they would look nice when they went home. The children measured food into plastic bags and emptied and cleaned the water bottles in preparation for the trip home. Because all but one of the students taking animals had to walk from school, each one found two friends to help carry the animal (transported in a cardboard box), the empty cage, the food, and the water bottle.

When the children brought the animals back to class after Thanksgiving vacation, they shared their experiences with one another. The girl who had taken the guinea pig thought that it had been "homesick" because it had not eaten the entire time away from the class. She said she had fed it the same type of food it usually ate.

The girl who had kept the rabbit had her mother help her bring the rabbit back to class. The mother talked about what a "frisky little critter" it was, and Valerie told us that it had eaten two plants and urinated on her mother's bed. She said her family had quickly realized that the rabbit could not be trusted alone outside of the cage. She also had discovered that the rabbit loved cabbage. The girl who had taken the hamster said that it had slept all day but was

active at night; one night the family stayed up until 2:30 A.M. watching it.

The fish group had left their animals in the classroom over the Thanksgiving holiday. They had to add two buckets of fresh water to the tank because water had evaporated and stopped the pump.

The students decided that we needed a class discussion on what to do about Christmas vacation. Many who asked their parents if they could bring an animal home over the ten-day Christmas holiday said that their parents didn't like the idea of having "rats" in their homes. The children asked me to write a letter to the reluctant parents saying that our animals were not rats. Five students helped me draft a letter which the students copied individually:

December 13, 1974

Dear Parents,

Help! Help! Help! Our animals need love and care over Christmas vacation. They cannot stay in our classroom because there will be no heat and no one to feed them.

None of our animals are rats. They are all of the rodent family but they are not rats.

We clean and feed them at school. Mrs. Wychocki doesn't have to clean or feed them. Each student who can care for an animal will feed it and clean it, not their parents.

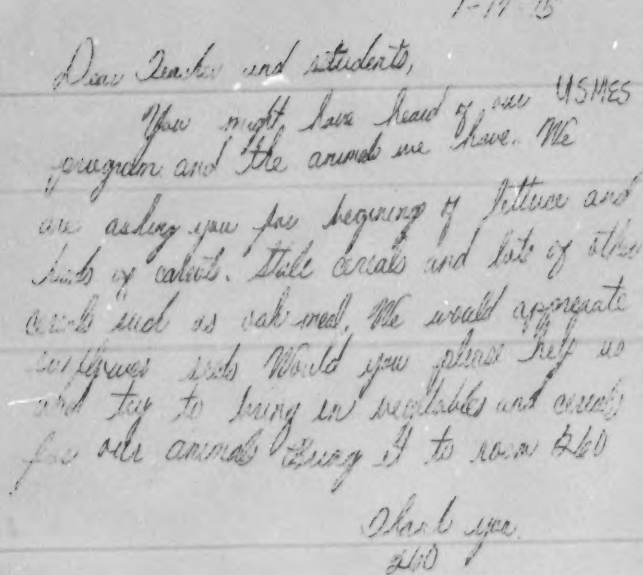
Please help us, let an animal come home for Christmas.

Sincerely,

Student's Name
Mrs. Wychocki

Many students added their own pleas for an animal under my signature. One student promised to do the dishes all during the holidays if she could bring the rabbit home.

The letter helped. In a few days, we had enough parents who agreed to let their child bring an animal home. When most of the animals had been taken home for the holidays,



1-17-75

Dear Teacher and students,

You might have heard of our USMES program and the animals we have. We are asking you for beginning of lettuce and tops of carrots. Stale cereals and bits of other cereals such as oat meal. We would appreciate any leftovers you would give us. Please help us and try to bring us vegetables and cereals for our animals. Room 9 to room 260

Thank you.
260

Figure C4-2

the students gave the room a thorough cleaning. The box turtle died over Christmas because a student had forgotten to take it home.

During the year, most of the groups brought in enough food or money to buy food for their animals to survive. However, we did have a critical period following Christmas vacation when we had no food in the classroom and no money to purchase food. We held a class discussion about the problem, and the students decided to bring dry cereal from home and to ask the local grocery store for spoiled or unsold vegetables. One student wrote a letter to teachers in the school requesting that they ask their students to bring in extra or spoiled food for the animals in our zoo. The letter is shown in Figure C4-2. The father or another student in our class brought in a paper bag filled with sunflower seeds, corn, and alfalfa pellets. Children in the class wrote "Thank you" notes to the father, and he was so impressed with their thoughtfulness that he obtained two 100-pound bags of mixed grain from the cereal plant where he worked. This huge supply solved the feeding problem for many of the animals. The children also made daily trips to the grocery store for discarded vegetables.

Use of the Design Lab was one of the major problems our class experienced during work on School Zoo. For two months we had no one to staff the Design Lab. The school hired an outside Design Lab manager who left after two weeks. After Christmas vacation we tried bringing the Design Lab into the classroom. We carried all the tools and available wood and Tri-Wall into the room and discussed the use of each item. Many tools, such as the chisel and planer, were unfamiliar to the students. Several children found the Design Lab "How To" Cards and began reading through them. Each student also received a letter about the tools and a permission slip to be signed by his or her parents before he or she could use them. Most parents signed the slip; a few gave permission to their children to use the hand tools but not the power tools.

The students felt that we needed to make a schedule for using some of the tools. We had enough measuring instruments in the room, but there was only one handsaw. At first the class discussed having different groups work during different times of the day. However, everyone wanted to work during USMES time so that they would not miss lunch or recess. The students decided that each group could use the handsaw for twenty minutes of each USMES period before giving it to another group. Several students brought handsaws from home so that they wouldn't have to wait to use the

class saw.

The class also discussed what activities, such as cleaning their animals' cages, other groups could be doing while waiting to use a tool. Some children salvaged sawdust from the cage construction process and used it as litter for their animals' cages.

We also had the problem of a wood shortage. At one point, the turtle, hamster, and guinea pig group met to discuss the possibility of building a large home to house the three animals together because there was not enough wood to build individual cages. However, the hamster group felt that it would be better to bring in wood than to risk the combination of animals; no one suggested experimenting to see whether they were compatible.

Two girls brought wood from home to use for their cages. Two other girls asked some surprised construction workers for wood for their school project; the men gave them some wood and nails.

So many cage construction projects were going simultaneously that some groups had to work in the hallway. For several weeks my room was one huge Design Lab. The noise from the building and complaints from the janitors finally led me to find a manager to run the Design Lab outside my room. The Design Lab was open most of the afternoon three days a week so that each group had a chance to build its cage. Details of the children's construction activities are described below.

I had brought several empty grape crates to school for children to use in housing their animals. Hoping to get a bird later, two boys decided to build a bird cage from two grape crates, using screen for the top. The children wanted to add a perch for the bird. They thought of using my pointer, but fortunately, it was too long. They asked for a dowel rod from the math teacher and fastened it to the cage. They then spent several USMES periods sanding the cage and painting it with tempera paint.

The hamster group decided to build a playpen for their hamsters out of wood and wire. The students decided that they would need wood, chicken wire, and nails for the project. They also decided that they needed to figure out the size of the pen and what material to use for the walls, floor, and ceiling. They made a rough drawing of the proposed pen, then tried to make a model from construction paper. When it was put together, they decided that the size was right for the hamster.

To construct the playpen, they began measuring and cutting the wood. The frame of their cage called for four

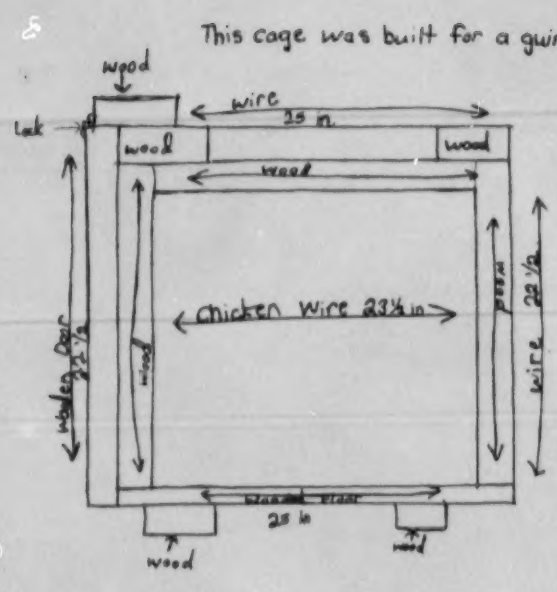


Figure C4-3

pieces of wood ten inches high. Using the yardstick, they measured ten inches on a six-foot 2" x 4". When it was their turn to use the saw, one girl held the wood while the other began to cut it. They tried for about fifteen minutes to get the saw going, then asked me for help. After several attempts I got the saw going through the wood and then handed it to one of the girls; they were disappointed that I didn't cut the wood for them. The first two pieces of wood were crooked. They tried to solve this problem by sanding the wood, but when I questioned them, they admitted that sanding didn't help. They decided to wait until the next USMES class to recut the wood. When the playpen was finished at last, the children put the male and female hamster in it. The male curled up in a ball ard went to sleep immediately.

The boys in the gerbil group spent two class sessions measuring and cutting a large piece of plywood for a gerbil playpen. After carefully drawing the parts on the wood to avoid any wastage, they began sawing it with a hand saw and were surprised at how difficult this was. They made the mistake of using chicken wire instead of smaller mesh wire for their cage, and the gerbils escaped through the holes. They soon corrected this error.

One girl in the guinea pig group brought in a cage of wood and wire which she had made at home for her guinea pig with her father's help. The other children admired the cage, but many said that they could do better without the help of others. The children were also critical of the cage because the girl painted it purple, and they were afraid that the paint would harm the animals.

A group of girls in the guinea pig group brought an old oak bookcase which they decided to disassemble and use to make a cage. (They made the cage with no prior design.) They had a great deal of difficulty using the wood for building. When they tried to pound a nail through two pieces, the noise was so loud that other students asked them to stop. They decided to move their project to the floor since the carpet would help muffle the sound of hammering.

Five boys formed their own guinea pig group and began building a cage. Their design for the cage is shown in Figure C4-3. Both groups completed their cages later in the year.

Students in the rabbit group first discussed the design of a cage for the rabbit early in the year. They made some early attempts to build the cage in the classroom but failed due to lack of space and the necessity of toting tools back

and forth between the room and the Design Lab. They decided to wait until the Design Lab reopened. When the group discussed finding a female companion for Freddie, they wanted to redesign their home for Freddie to include the new rabbit (which they never acquired). They decided to build a huge cage that could be separated in the middle by chicken wire when the female rabbit became pregnant. The children felt this would be important because they had read that the male would kill the baby rabbits if he lived with them. In their design of the rabbit cage (which they called a "hutch") they included a litter box, private bedroom, and a play pen. The design is shown in Figure C4-4.

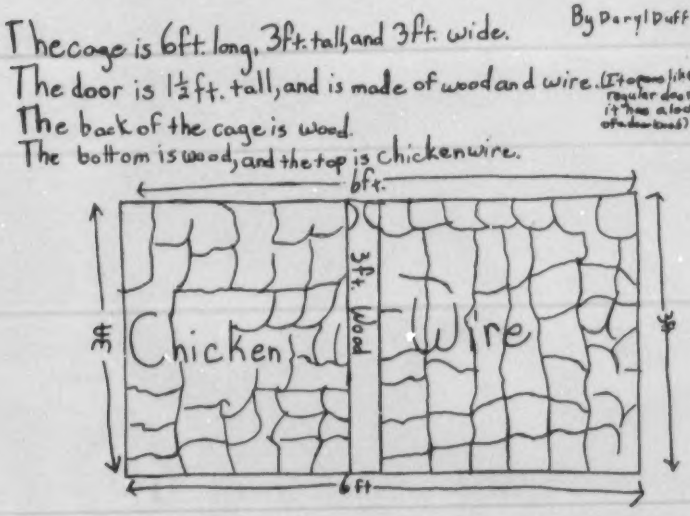

The cage is 6ft. long, 3ft. tall, and 3ft. wide.
By Daryl Duff
The door is 1½ ft. tall, and is made of wood and wire. (It opens like a regular door, except it has a lock instead of a doorknob)
The back of the cage is wood.
The bottom is wood, and the top is chickenwire.
6ft.
3ft.
1½ ft. Wood
Chicken Wire
3ft.
6ft

Figure C4-4

First Homemade Rabbit Cage

The rabbit group began measuring their wood with a measuring tape, using the measurements stated in their design. They laid newspaper on the floor and elected two girls to sit on one end of the wood while another girl sawed. After they had cut the wood, they used planes to make it smooth.

Tht children were proud of the huge cage that they made but were shocked at how difficult it was to clean. Children cleaning the cage had to crawl into it, a most unpleasant experience, as the rabbit was very messy.

To raise money to buy wood for the rabbit cage and other materials, the children held a second bake sale. This

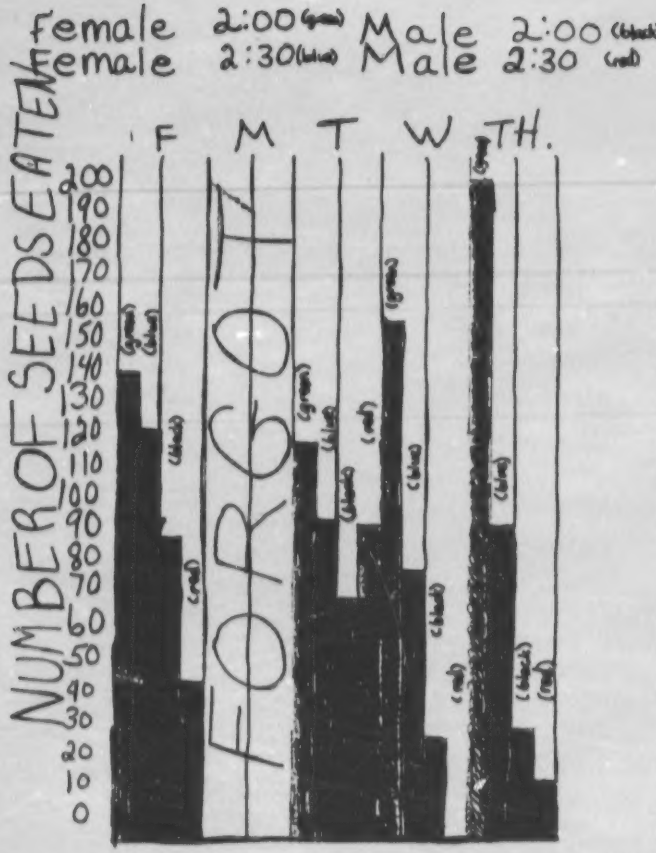


Figure C4-5

sale was conducted like the first; children made posters and issued oral invitations to other classes. After the sale the class listed the materials that they needed to buy, including wood, nails, hinges, wire cutters, a scale, fish food, and other supplies for the classroom and the Design Lab.

The disorder of the room was a continuous problem during the course of the unit. Although the children cleaned their animal cages regularly, the back of the room accumulated junk and construction material quite rapidly. We spent several sessions cleaning the whole room. At one point when the Design Lab was in the room, I requested a class discussion on how to keep the room in order. All the students agreed that the room needed a good cleaning and that we should decide on a place to keep everything so that we could maintain order in the future. The boys would not volunteer for cleanup; I heard one boy state that it was girls' work to clean. After this remark I stepped in and assigned three boys to help three girls think of a solution to the problem. The six students asked the janitor if he would lend them a broom and carry out the broken aquaria in the back of the room. They spent nearly two hours cleaning and assigning each group a place to keep their animals and equipment.

Besides constructing homes for the animals and caring for them, the children became fascinated with watching their daily behavior and looking up information in books. For the sake of clarity, the observations of each group are reported separately below.

* * *

Hamster

The children in the hamster group became interested in hamster behavior. One day when one of the girls was cleaning out the hamster's cage, she found the hamster had stored his favorite food, sunflower seeds, in his bed. The children were interested in the hamster's storing habits and decided to conduct an experiment to see how many sunflower seeds each hamster could store. They recorded the number of seeds each hamster put in its pouch at 2:00 P.M. and at 2:30 P.M. each day and made a bar graph of the results (after a special session on graphing). The bar graph appears in Figure C4-5. The children noticed that Goldie, the female, stored many more than Ermine, the male, who curled up and went to sleep after a while. The children also tested Goldie to see if she preferred celery or carrots by putting

her in front of both vegetables. Five out of six times she ate the celery before the carrots.

Two children from the hamster group did some library research on hamsters after school. They wrote reports and shared their information with other interested students. Their report included the following facts:

1. Hamsters in the wild live in tunnels.
2. The word "hamster" is German in origin.
3. They look for food at night.
4. They hide food in their inner cheek pouches.
5. They live in Europe and Western Asia, where they are considered pests because they damage crops.
6. Wild hamsters are known to grow a foot long; they have thick hair on their backs.

The children in the group decided to try to mate the male and female hamsters so that they could have babies. They referred to a book on hamsters which told them that hamsters mate during the night. However, the children were reluctant to leave them alone at night for fear that they would fight. But whenever they put the two together, other children crowded around the cage to watch the mating ritual. The children in the group were upset because they felt that the hamsters needed privacy, and they put them together for an hour in the empty classroom next door. They used the method of getting the animals used to each other described in their book on hamsters: the male's and female's cages are first placed next to each other for awhile; then the female is put into the male cage. However, the hamsters frequently fought together or the male crawled into a corner to sleep. Feeling that darkness might induce more romantic behavior, the group later tried locking them together in the supply closet.

After several months of trying to mate the male and female hamsters, the children noticed that the female was looking fatter and that her nipples were swollen. One morning they discovered twelve babies in her cage. All the children were very excited. The children in the hamster group warned everyone to be quiet and not to touch the babies. The following day there were only eleven, and the children concluded after research in a hamster book that one had died and the mother had eaten it.

When the babies began to get their fur, the children noticed that some of the hamsters were white like the father and some were brown like the mother. Later they made plans

Cynthia Bradley Room 5
Horace Mann April 1, 1975

How the
Hamster Got its Name

In the year 1905, there
was a scientist who was called
Dr. Ster. He always was
coming up with new inventions.
One day he invented an animal
who loved to eat ham.
People came from miles around
to see this animal. Dr. Ster
made lots of more of these animals.
He made tons of money and there
was only a slight problem, the
animal had no name.
Just then Dr. Ster's assistant
came in and said "The animal
is eaten all the ham Dr Ster!" When
Dr Ster heard he said repeated.
This time the assistant didn't call
him Dr she said the animal
has had eaten all the ham
Ster. That's it. That's what
we should be accepted. That's who
we will name the animal...

Figure C4-6

to mate the female with a brown hamster belonging to another class to see if the babies would be all brown. They also began discussing what to do with the baby hamsters when they grew bigger.

One girl in the hamster group wrote a story about how the hamster got its name. (See Figure C4-6.)

Gerbil

The gerbil group spent some time observing their pets. They noticed that gerbils eat seeds, grass, roots, and grains. In November six gerbils were added to the zoo and the group decided to give two of them to two boys who would form a second gerbil group. The boys wanted two that were compatible. The group of students watched the gerbils at play for a while to find out which gerbils paired while playing. Because they wanted to keep them in the same cage, the boys selected two and immediately placed their new pets in an empty aquarium with some old towels which the gerbils could shred for bedding.

One of the gerbil groups found their plastic water bottle broken one morning. They discovered that a crack in the plastic had broken the vacuum that kept the water from running out when it was turned upside down. They started to repair the crack with rubber cement, but other students in the class joined the discussion and convinced them that the cement might harm the gerbils. They used masking tape as a temporary solution. A few days later someone brought in a plastic doll bottle to use instead of the broken bottle. The children kept measurements of the amount of water their gerbils could consume in a day and found that they averaged about two ounces a day.

When one of the gerbils escaped into the heater, the children cleverly figured out a way to capture it. They took a long paper roll, put food inside, and laid it near the heater. When the gerbil ran into the paper roll for the food, the children covered the ends and captured it.

Guinea Pig

The children in the guinea pig group compiled a list of foods that the guinea pig would eat: green vegetables, celery tops, lettuce, spinach, apples, tomatoes, and bread. They tried an experiment to determine its favorite vegeta-

Pete Rm 240
Howe Manor Jan 14, 1974

I think I should get the G.P because I think could really take good care of it I shall equip it with food and water bottle and I will try my best to keep it alive and healty and I will give it a home

Figure C4-7

tables. They set it in front of lettuce, carrots, and tomatoes and watched what it did. The group ran the experiment eight times, making sure to move the vegetables into different positions. Each time the results were the same: the guinea pig would first eat the lettuce, gnaw on the carrot, sniff the tomato, and return to the carrot. The students also discovered that their guinea pig would eat white bread, but not whole wheat bread, and preferred vegetables to any kind of bread.

The children also conducted an experiment to see how much water their guinea pig drank in a forty-eight-hour period. They filled three water bottles with 20 fl. oz. of water each and attached them all to the guinea pig's wire cage. At the end of the two-day period they measured the total amount of water used and decided that the guinea pig had drunk 45 fl. oz. in two days.*

A substitute teacher in the school donated three new guinea pigs to the school zoo. The students decided that whoever wanted a guinea pig should write a letter to me explaining why they wanted it and how they could care for it. One of the letters I received is shown in Figure C4-7. After reading their letters, I chose the three students to receive guinea pigs. These three children wrote letters of thanks to the substitute teacher and then set about finding homes for the new animals.

One child decided to use the ten-gallon aquarium which had housed the toad (now dead). She cleaned out the dried mud and dead plants in the bottom and covered the floor with cedar chips borrowed from the rabbit group. Another student housed her guinea pig in a cardboard box lined with newspaper. The third child found an aquarium with a crack, which he tried to repair with rubber cement. He asked three other boys to help him blow on the cement so that it would dry before they left at 3:00 P.M.

One child solved the problem of finding feeding containers by asking the cafeteria staff for ten empty milk cartons for holding water and food.

One morning, the children were upset over the death of their favorite guinea pig, a long-haired one named Sandy. The children decided to put the three remaining guinea pigs

*The children might keep records over a longer time period on the foods eaten and the amount of water drunk. They might check whether there was variation from day to day and discuss possible reasons for any variation.--ED.

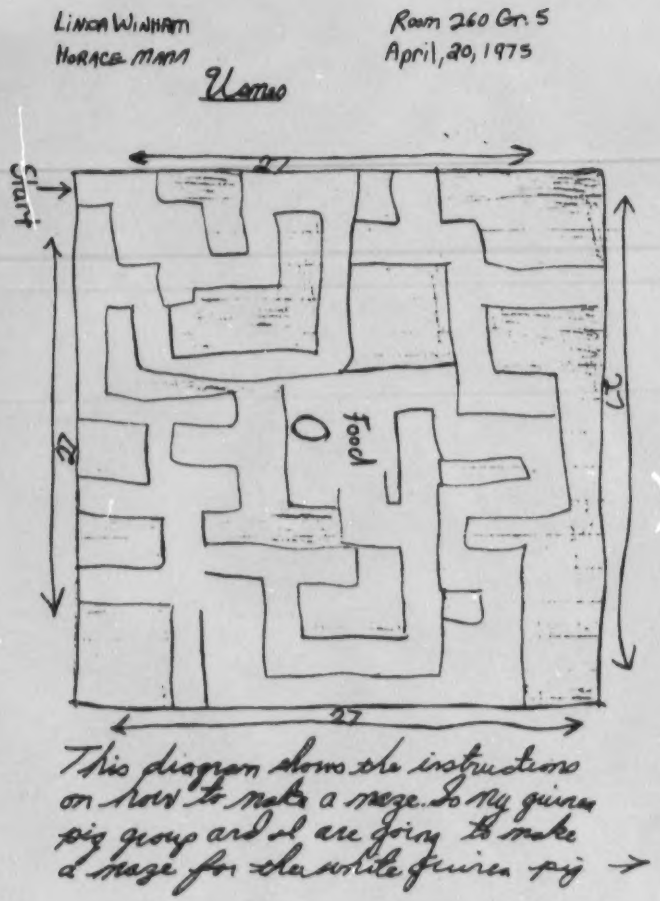

Linda Winham
Horace Mann
Room 260 Gr. 5
April, 20, 1975
Memo
Start
27
27
27
Food
This diagram shows the instructions on how to make a maze. Do my guinea pig group and I are going to make a maze for the white guinea pig

Figure C4-8

together to see what would happen. The two females fought when the male was present. When the male was not present, they also fought unless there was food in the cage. They put the male guinea pig with one of the females, hoping they would mate and produce young ones. However, the students noticed that the animals would lose interest in each other if food was present.

One boy tried an interesting experiment with one of the guinea pigs. He put seven different cages in a circle, all equipped with food and water. Then he put the guinea pig in the center to see if it could find its own cage. All three times it went to its own cage.

Another of the guinea pig groups measured the total distance their guinea pig traveled in ten minutes by marking the points where it shifted direction with masking tape, measuring between the points, and adding all the measurements together. When they first tried this, they found that the guinea pig walked 26 ft., 7 in. in ten minutes. This activity led to the idea of constructing a maze out of cardboard. One of the girls in the group drew the design for the maze, which appears in Figure C4-8. The group constructed the maze in the Design Lab and put their guinea pig, Snowflakes, in one corner and lettuce in another. When the guinea pig smelled the lettuce, it tried to climb over the partitions, but the children put out their hands to stop it. They timed the guinea pig and found that it took four minutes, thirty-six seconds to get the food. During the next session, the guinea pig's time improved, but they concluded that another guinea pig, Dimsey, was smarter because it took less time to go through the maze. The children recorded the following times for the three trials:

	Snowflakes	Dimsey
1st	4:31	2:03
2nd	4:02	1:48
3rd	3:11	2:01

Rabbit

While waiting to begin constructing their rabbit cage, the rabbit group experimented with different ways to make Freddie the rabbit comfortable. They decided to leave him outside his cage for a whole weekend and blocked off a portion of the room to use as a pen. One girl lined the floor

Valerie Pimpsey Room 26
Horace Mann Jan 13, 1979

Names

our report for today was.

Treasurer Report

Today we all put in some money all together we have 96¢.

Secretary's report

We talked about the things that we need for our rabbit. We talked about the kinds of food he will eat.

Figure C4-9

with large pieces of plastic to protect it from the rabbit droppings. The children placed a kitty litter pan in one corner, hoping that the rabbit would learn to use it. They used yarn to hang carrots from the bookcase (believing that the rabbit would take longer to eat hanging food than food lying on the floor) and wire to hang the water bottle. When they returned to the room the following week, the group discovered not only that the rabbit did not learn to use the kitty litter, but also that he made a terrific mess in his free corner. After cleaning the corner for nearly two hours, children in the group decided never to leave the rabbit loose in the room without someone to watch him.

Members of the rabbit group had several meetings to decide how to raise money for its food. The group decided to bring in a certain amount of money each week to buy dried food. They also planned to bring dry bread and unsugared breakfast cereal from home and to visit the local grocery store and ask for vegetables not suitable for sale. Later, the group formed a Rabbit Club and elected officers who collected dues so that they could buy a female rabbit. (See Figure C4-9 for the report of the day.)

On Friday the children in the rabbit group discovered that they could not find the key to his cage. The group searched for forty minutes with no success. The children decided to try to get food to the rabbit before leaving for the weekend. They stuck a yardstick through a small hole in the top of the cage and used it to push the empty food bowl under the hole. Then they pulled out the yardstick and used a funnel to pour food through the hole into the bowl. On Monday many students brought old keys which opened luggage, jewelry boxes, safe deposit boxes, doors, and locks. They tried sixty different keys, but none fit the rabbit lock. After working the large part of a day on the lock, two boys managed to move the latch enough to open the door without destroying the screening. When the rabbit was released, the children noticed that he needed exercise and did not want to be picked up.

In the spring some of the children in the rabbit group made up a story and dressed the rabbit in an Easter Bunny outfit as an Easter treat for the primary grades. They crocheted his outfit themselves from yarn.

The children tried to keep records of the amount of food and water the rabbit consumed in one day. They found that he drank about two cups of water a day and ate around two and one-half cups of dried food as well as any vegetable he was given, but they felt that he could have eaten almost any amount of food he received.

Daryl Lynn Duff Apr. 1 23 1975

USMES

Today in USMES I went to the main library to find out about the rabbit. I found out how to tell a rabbit from a hare and the difference of how they ~~so~~ have and care for their babies.

The difference between rabbits and hares is that a hare is larger and heavier and has longer ears. With its longer hind legs and larger hind feet, it can out outjump ~~and~~ any rabbit and it doesnt get tired as quick

Figure C4-10

The children had originally planned to capture a wild rabbit to mate with Freddie, but this idea was abandoned. Later one of the children looked up the difference between a rabbit and a hare and realized that a domestic rabbit like "Freddie" was really a hare. Her report is included in Figure C4-10.

Bird

The bird group constructed their cage long before they obtained a bird. They decided to buy a parakeet but had difficulty deciding how to get it. After spending a long time building the cage, they still felt that it wasn't strong enough to hold a bird. When the boys finally bought a parakeet at the local dime store, one boy brought an old bird cage from home.

The group was very excited by their pet and tried to train it to sit on their fingers. This proved to be a disaster, however, when they opened the cage door. The bird flew off the boy's finger and around the classroom. The next hour was chaotic, but the children finally caught the bird by setting a very clever trap. They took the top off his cage and stuck a stick through the wire and out of the top. They moved the branch around until it caught the bird's eye. When it saw the moving branch, it flew down and landed on the stick. The children gently lowered it into the cage and quickly slapped the lid on.

The children were very upset one morning to find the bird dead. They had not been able to solve the problem of having no heat in the school building at night. One of the boys expressed his anger with the bird for not being able to live in the cold, but the other admitted "I blew it!" The boys talked about obtaining a new bird but never did.

Fish

In the fall the children in the fish group decided to empty the fifteen-gallon fish tank and move it to a better place in the room. From home they brought three fish bowls to house the fish temporarily during the move. They then spent several USMES periods emptying, cleaning, moving, and refilling the aquarium. They added clean gravel and replanted the water plants in the bottom of the tank. The group discovered that when a large amount of water had evaporated from the fish tank, the filter stopped working.

The children had to add water often to keep this from occurring. Later, the group became frustrated with the filter because it stopped nearly every night, and they had to spend part of each USMES period to start it again.

The children tried to run a food preference test on the fish with three different brands of food. Although they watched the fish to see if they ate one kind before another, they saw no preference. When they read the ingredients on the boxes, they saw that all of them contained the same ingredients.

When the children took the fish home for spring vacation, they forgot to unplug the heater, and enough water evaporated from the tank to cause the heater to shatter. They spent several sessions cleaning up the mess it made of the tank and returned all the fish to the aquarium a few days later.

The children in the fish group were envious of other children who, they felt, had more interesting animals to work with. One of the girls in the group decided to get a baby hamster as soon as the young ones in the litter were old enough. I overheard one comment from the group that "fish might be boring, but at least they're not messy!"

Insect

This group was rather transitory and was made up of children who got tired of working with other animals. One boy found ants all over his apartment building and decided to catch some and set up a colony. He and another boy succeeded in capturing some in a jar, but they left them on the window sill and ignored them, and they all died.

In the spring three girls got together to talk about bringing in insects and housing them in an empty tank. Several kinds were collected and observed. The children looked up the insects in their collection in a book called *Know Your Insects* which they checked out of the library. Some one also brought in a snail, and the fascinated children watched it eat a worm. One child's account of this is given in Figure C4-11.

The children had been keeping two cocoons in the class all year. One day they observed movement in one of them; a few weeks later a beautiful moth emerged. The children noticed that it looked feeble and they let it go on the window sill. Later someone found it dead outside, and the children pinned the moth with its cocoon to their bulletin board as part of

Daryllyne Duff 5-1-75

USMES

Today is USMES I watched a snail try to devour a worm. It was very interesting because the snail came in and out of the shell and its entrances kept going up, down, up, and down. Charles brought his camera and we took 2 pictures of the rabbit and one of Valerie and me teaching him to do his business in the kitty litty pan.

Figure C4-11

a display. The second cocoon hatched soon after. This time the children took the moth outside immediately after they had examined and admired it.

* * *

During the spring months, the children continued to write reports on their animals to include in their USMES folders. The class also made a bulletin board display of some of their best reports and drawings.

In December the class had held a discussion about opening the zoo to the school in the spring. They had listed on the board questions which needed to be answered before the opening, such as "What temperature do our animals need to survive?" and "How and where can we get some new and different animals?"

During March the children made more definite plans for the zoo opening. They decided that they would display pictures of their animals, charts showing the amount of water or food consumed, and reports and booklets on the things they had learned about their animals.

One idea that blossomed into a very creative production on the part of several students was the plan to put on a "radio program" over the school intercom system to advertise the opening of the zoo. The children decided that they would do the following things during this program:

1. Tell animal jokes.
2. Make up and read poems about our zoo.
3. Advertise a "made-up" animal food for their favorite pet.
4. Play records that have an animal name in the title.
5. Write a story on "What do the animals do in Room 260 at night."

The group of students working on the "radio show" met at lunch or recess because USMES period was too noisy. They originally planned the show for April 3, but school was cancelled that day due to a snowstorm. The show was finally produced on May 8.

The show consisted of stories, poems, and songs, as well as animal jokes, music, and a commercial, written by different students. One student acted as announcer while the students who had written pieces read them aloud. The whole class concluded the show by singing a song about their zoo and each animal in it to the tune of "Old MacDonald Had a Farm." The production was a great success, and the children

received many compliments on their work. Excerpts from the show are given below.

RADIO PROGRAM, SCHOOL ZOO
ROOM 260 HORACE MANN, CHICAGO, ILL.
BROADCASTED ON 5-8-75

The program began with music, titled "Animal Square Dance."

Michael:

Good afternoon. What you have just heard was the "Animal Square Dance." This is Room 260 broadcasting live from the top of Horace Mann Demountable. You are listening to W U S M E S.

Michael:

We have a little guinea pig, a big one too, if you don't believe me, come to the school zoo. Speaking of a guinea pig, here is a story about a guinea pig and his friends.

THE GREAT ESCAPE

Linda:

It was 6:30 in the morning and Dimsey and Snowflakes both had broken out of their cages. Together they were hunting for the guinea pig treat. All of a sudden they passed the hamster cage. The hamster said, "What are you, and what are you looking for?" "We're guinea pigs and we're looking for the guinea pig treat," said Dimsey. "Well let me out of my cage and let me come too, 'cause I'm just dying to get some more of that hamster treat," said the baby hamster.

"Well come on before Mrs. Wychocki gets back," said Snowflakes. So all three of them were hunting together looking for their treats, when they passed Lisa, another guinea pig. She said, "Hey man, what's going on this groovey morning?"

"Well, Snowflakes and I are hunting for our treats, and so is this here baby hamster," said Dimsey. "Well, I'm coming, too," said Lisa.

So the four of them were hunting for their treats. Then once again they meet Fred, the rabbit, and Lisa said, "Hey, man, how many carrots you got?" "I got plenty for myself and none for you, but if you let me out I'll share with all of you," said Fred.

So that was just what they did. Soon all five of them were hunting. Four were hunting for treats, and Fred was just tagging along. Soon they reached the bird cage, and this is what that big mouth parakeet said, "Polly wants a cracker and I see five of them." "Well who you think you are calling us crackers?" said Snowflakes. "I'm a parakeet, too bad you're not," said the parakeet. "Well, you better shut up if you want to stay a parakeet," said Dimwey.

So they again traveled, if that's what you call it, around the room. They passed the gerbils and one said, "What is it, where'd it come from?" "Never mind that, 'cause here comes Mrs. Wychocki," said the other gerbils. The rabbit couldn't help over hearing that so he shouted, "Everybody, here comes the teacher." So, all the animals ran back to their cages and made it just in a nick of time.

Michael:

How about that story, folks! The Great Escape, it was written and read by Linda Windham.

And now a little music titled FUNKY PENGUIN.

[PLAY RECORD TITLED FUNKY PENGUIN.]

Cynthia:

We interrupt this program with a FLASH BULLETIN FROM EL PASO, TEXAS. [Read Bulletin.]

STUDENTS ELECT A RAT TO A STUDENT SENATE SEAT.

Students at the university elected a hamster to the Student Senate seat. The hamster by the name of Stripers, ran under the slogan:

HE IS THE ONLY ONE HCNEST ENOUGH TO ADMIT HE IS A RAT

The students are worried because Stripers is not a registered student.

****

All:

ANIMAL DANCE

The parakeet dances on the floor, and the guinea pig dances with two feet more.
The goldfish dance on the end of their tail, on the count of one two, and the ring of the bell.
The rabbit doesn't dance, but it does the hop, but when it does dance, it does the rabbit rock.
The gerbils do the twist when they are in their cage, but on the ground they are mostly afraid.
The monkey dances the proper way, 'cause he practices every week and almost every day.
Animals dance in the strangest way, I wonder if they sing?
Could they? They may.

****

Cynthia:

If you want a glimpse of any of these creatures you must come to 260's school zoo the week of May 13, 1975.

****

Michael:

(sounding like Woody the Woodpecker he says,)

THAT'S ALL FOLKS!

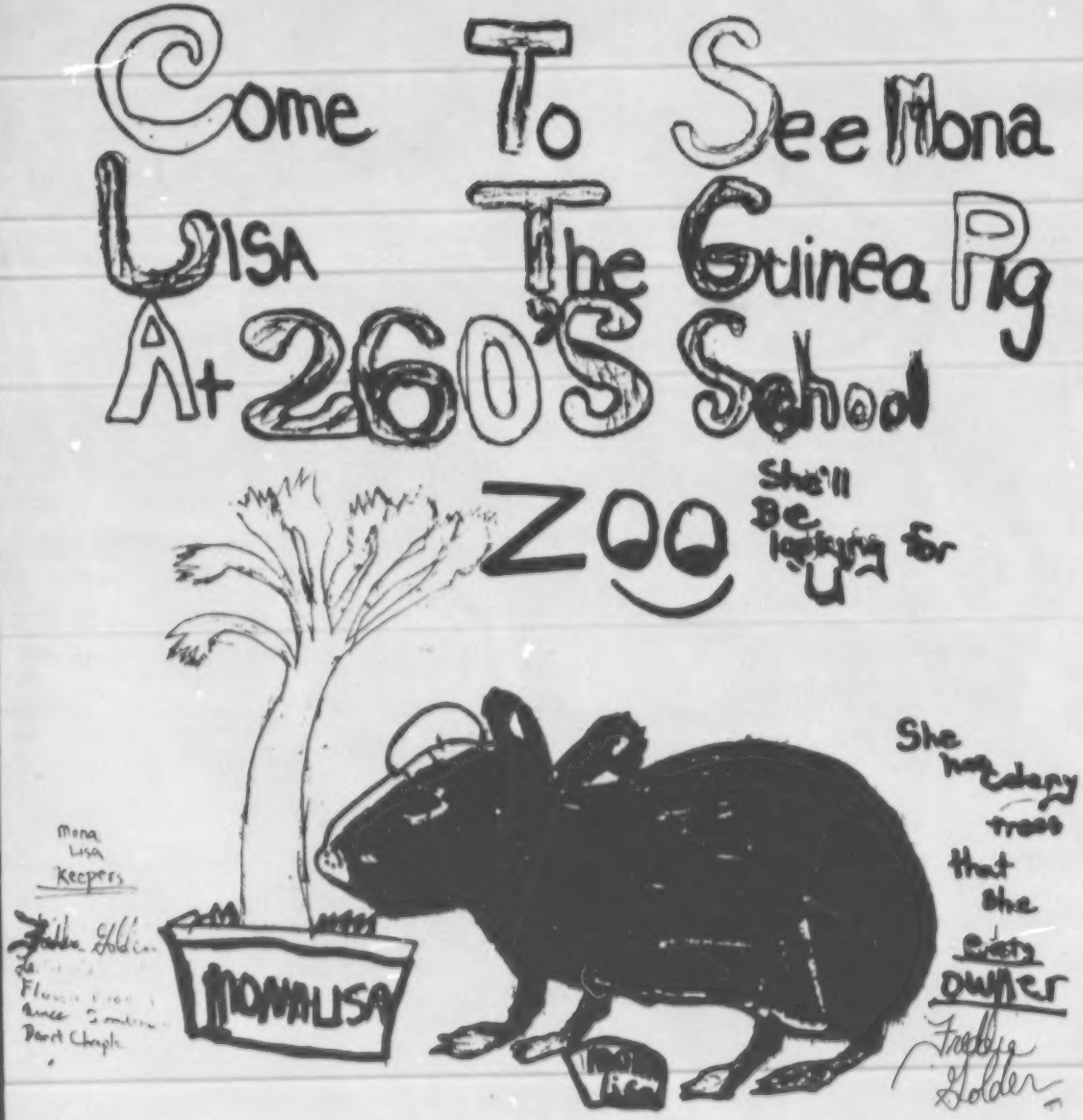
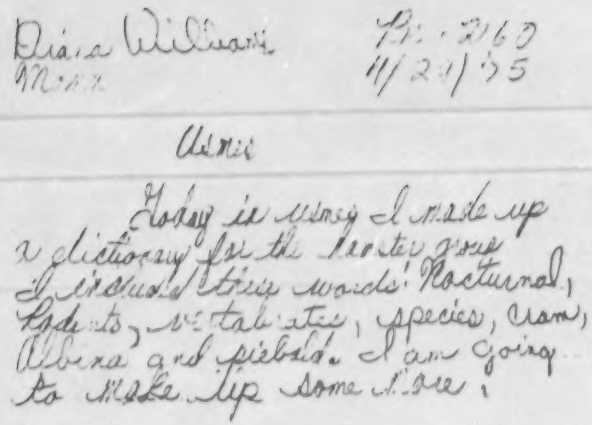

Come To See Mona Lisa The Guinea Pig At 260's School Zoo
She'll be looking for
MONALISA
Mona Lisa Keepers
She has eaten trees that she eats
owner
Freddy Golder

Figure C4-12


Diana Williams
Mrs. [illegible]
11/24/85

Today in Library I made up a dictionary for the hamster group. I include these words: Nocturnal, Lobes, Nictalopia, species, Cam, Albera and piebald. I am going to make up some more.

Figure C4-13

Meanwhile, other children in the class worked on preparing the zoo for the Open House scheduled for May 13-22. The children decided to expand their class bulletin board display into a large exhibit that children from other classes could see and read when they came to the Open House. One student from each animal group worked on the display. The children also made posters, such as the one shown in Figure C4-12, advertising the Open House.

The hamster group decided to make an informational booklet on hamsters for the zoo. One girl put together a glossary of terms for the back of the booklet. Her report on this activity is shown in Figure C4-13. The mother of one of the children typed the book and duplicated copies to be distributed at the Open House (one per class). The group also weighed the baby hamsters and included the weights on a chart for the opening. Before the Open House they grouped all the hamster cages (about nine in all) in one area of the classroom.

The gerbil group let their visitors hold the gerbils while they read them information. They displayed the following things on tagboard:

1. Who gerbils are related to
2. What gerbils are
3. Diagram of their cage
4. Short paragraph on gerbil history
5. Diagram showing parts of the gerbil body
6. Short creative story on "Super Gerbil"

The girls working with the male guinea pig made a "Guinea Pig Guide" to distribute at the Open House. The inside pages of the guide are shown in Figure C4-14. The boys who cared for another of the guinea pigs made a display with various diagrams and charts, including a drawing showing the guinea pig body parts. They wrote a description of the experiment that they had done to find out if the guinea pig could identify its own cage among a group of cages.

The rabbit group prepared several charts and drawings showing a rabbit skeleton, food preferences, and other information. Children in this group recorded some of their information on tape for primary children who they felt would not be able to read many of the reports.

When the zoo opened for the first time, the children were very nervous. During the first session they stood around and said little, but later groups asked many questions which loosened them up. Children in the guinea pig group noticed that other fifth graders were often frightened by their

General Information

Appearance: A tailless animal. Weight about 2 lbs.

Reaches a lenghth of about 6-10 inches.

Uses: Medical experiments, pets. (Was used as food by the Incan Indians.)

Natural Home: Lives in burrows from Bolivia to Chile.

Food: grass, leaves, and fruit

Our guinea pig, Snowflakes

We've been doing experiments with Snowflake and have found that, she can run over 24 feet in 10-15 minutes, it only takes her a few minutes to find hidden food in her maze, and from the choice of bread, lettuce, nuts, seeds, or a carrot, she almost always picks lettuce to eat.

Figure C4-14

guinea pigs, while first graders wanted to hold them. The gerbils attracted a lot of attention because some of the children thought they were rats. The children explained that they were not rats but, like rats, they belonged to the rodent family. Children asked many informational questions about the animals, while teachers asked such questions as "Do they distract you from your work?" or "Who cleans the cages?" Following the Open House, the children wrote reports on the experience such as the one shown in Figure C4-15.

Jane Brown
Horace Mann School

Room 260
5/14/75

USMES

Today We told the people what name to name them. They asked us questions about what is that animal? is that a mouse? and what is its name. The animals were sleeping too. The Hamsters didn't fight today when the classes came in. One of the Hamsters was sleeping in the wheel. We told them about the differents from a male hamster and a female hamster.

Figure C4-15

D. References

1. LIST OF "HOW TO" CARDS

Below are listed the current "How To" Card titles that students working on the School Zoo challenge may find useful. A complete listing of both the "How To" Cards and the Design Lab "How To" Cards is contained in the USMES Guide. In addition, the Design Lab Manual contains the list of Design Lab "How To" Cards.

BIOLOGY

B 1 How to Plan a Home for your Small Animal

GRAPHING

GR 1 How to Make a Bar Graph Picture of Your Data
GR 3 How to Make a Line Graph Picture of Your Data
GR 4 How to Decide Whether to Make a Bar Graph Picture or a Line Graph Picture of Your Data
GR 7 How to Show Several Sets of Data on One Graph

MEASUREMENT

M 1 How to Use a Stopwatch
M 2 How to Measure Distances
M 9 How to Make a Conversion Graph to Use in Changing Measurements from One Unit to Another Unit
M 10 How to Use a Conversion Graph to Change *Any* Measurement in One Unit to Another Unit

PROBABILITY AND STATISTICS

PS 2 How to Record Data by Tallying
PS 3 How to Describe Your Set of Data by Finding the Average
PS 4 How to Describe Your Set of Data by Using the Middle Piece (Median)

RATIOS, PROPORTIONS, AND SCALING

R 1 How to Compare Fractions or Ratios by Making a Triangle Diagram*

*Presently called Slope Diagram

New titles to be added:

How to Round Off Data
How to Record Your Data
How to Design an Experiment

A cartoon-style set of "How To" Cards for primary grades is being developed from the present complete set. In most cases titles are different and contents have been rearranged among the various titles. It is planned that this additional set will be available in 1977.

2. LIST OF BACKGROUND PAPERS

As students work on USMES challenges, teachers may need background information that is not readily accessible elsewhere. The Background Papers fulfill this need and often include descriptions of activities and investigations that students might carry out.

Below are listed titles of current Background Papers that teachers may find pertinent to School Zoo. The papers are grouped in the categories shown, but in some cases the categories overlap. For example, some papers about graphing also deal with probability and statistics.

The Background Papers are being revised, reorganized, and rewritten. As a result, many of the titles will change.

BIOLOGY

B 1 How to Love Frogs by Abraham Flexer
B 2 Raising Houseflies by Abraham Flexer
B 3 Identifying Organisms by Abraham Flexer

GRAPHING

GR 3 Using Graphs to Understand Data by Earle Lomon
GR 4 Representing Several Sets of Data on One Graph by Betty Beck
GR 7 Data Gathering and Generating Graphs at the Same Time (or Stack 'Em and Graph 'Em at One Fell Swoop!) by Edward Liddle

GROUP DYNAMICS

GD 2 A Voting Procedure Comparison That May Arise in USMES Activities by Earle Lomon

MEASUREMENT

M 3 Determining the Best Instrument to Use for a Certain Measurement by USMES Staff

PROBABILITY AND STATISTICS

PS 5 Examining One and Two Sets of Data Part I: A General Strategy and One-Sample Methods by Lorraine Denby and James Landwehr

RATIOS, PROPORTIONS, AND SCALING

R 1 Graphic Comparison of Fractions by Merrill Goldberg
R 2 Geometric Comparison of Ratios by Earle Lomon

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3. BIBLIOGRAPHY OF NON-USMES MATERIALS

The following books are references that may be of use in teaching School Zoo. A list of references on general mathematics and science topics can be found in the USMES Guide. (Publisher's prices, where listed, may have changed.)

Reference Books for Teachers

Elementary Science Study (ESS). McGraw-Hill Book Co., Webster Division, Princeton Road, Hightstown, N.J.

_____. *Animal Activity.* ($2.46) Teacher's Guide - Activity Wheels.
This booklet describes how to design animal activity wheels and discusses experiments children can try with animals and their wheels.

_____. *Animals in the Classroom.* ($3.78) Teacher's Guide.
Gives excellent description of keeping desert animals (gerbils and lizards) in the classroom.

_____. *Behavior of Mealworms.* ($4.20) Teacher's Guide.
If students cannot find other insects as food sources, mealworms are a valuable alternative.

_____. *Brine Shrimp.* ($2.46) Teacher's Guide.
Describes raising brine shrimp, which might be a useful source of food for other animals.

_____. *Butterflies.* ($3.48) Teacher's Guide.
Describes the construction of nets and cages for butterflies and caterpillars, and food for different species.

_____. *Crayfish.* ($2.46) Teacher's Guide.
A useful book describing the care of crayfish.

_____. *Earthworms.* ($3.54) Teacher's Guide.
As well as being interesting animals in themselves, earthworms may be useful as a source of food.

_____. *Eggs and Tadpoles.* ($2.82) Teacher's Guide.
Gives information on how to raise tadpoles.

_____. *How a Moth Escapes from Its Cocoon.* ($1.50).
Describes life cycle of moth and in particular, how a caterpillar becomes a moth.

_____. *Mosquitos*. ($2.61). A Resource Book for the Classroom.
Raising mosquitos from larvae may provide a food source for small frogs, etc.

_____. *Pondwater*. ($2.82). Teacher's Guide and Student Cards.
A very useful guide if your students wish to bring in pond animals. The guide and accompanying cards will help with making and setting up an aquarium and identifying the creatures found.

_____. *Small Things*. ($4.95). Teacher's Guide.
Some classes have found that looking at small animals under the microscope helps to identify them. This describes activities children can do with microscopes.

_____. *Stream Tables*. ($8.40). Teacher's Guide and Cards.
Although the activities described are more geological than biological, the description of making a stream table might be helpful should your class wish to make one for their animals.

Foundational Approaches in Science Teaching (FAST).
Write to University Laboratory School, University of Hawaii, Honolulu, Hawaii for information on animal care and on raising insects and crustaceans.

Merrick, Paul D. *The Housefly as a Classroom Animal*.
Educational Science Consultants, P.O. Box 1674, San Leandro, California 94577, 1967.
This book gives useful information about raising houseflies in the classroom. Useful for providing a constant food supply for amphibians and reptiles.

MINNEMAST Series, Minnesota Mathematics and Science Teaching Project, University of Minnesota, 720 Washington Avenue, S.E., Minneapolis, Minnesota 55455.

_____. *Unit 23, Conditions Affecting Life*.
Describes simple experiments to find the preferences of insects for humidity and light.

National Wildlife Federation (NWF) Environmental Investigations (Teacher's Guides). Written by Minnesota Environmental Sciences Foundation, Inc. Available from NWF, 1412 Sixteenth St., N.W., Washington, D.C.

_____. *Brine Shrimp and Their Habitat.* ($1.50).
Describes maintenance and observation of shrimp in the classroom.

_____. *Change in a Small Ecosystem.* ($1.50).
Children can make their own small ecosystems (using pond water or soil) in jars and watch them change. This is useful if children add a mini-ecosystem to their zoo.

_____. *Fish and Water Temperature.* ($1.50).
This book shows how breathing rates of fish correlate with water temperature.

_____. *Genetic Variation.* ($1.50).
Although this concentrates on genetic variation in people and plants, methodology may be useful for School Zoo when children notice variation in color and markings in baby mammals.

Nuffield Junior Science. Distributed by Agathon Press, Inc., 150 Fifth Ave., New York, N.Y. 10011

_____. *Apparatus: A Source Book of Information and Ideas.*
Tells how to make some insect cages easily.

_____. *Animals and Plants: A Source Book of Information and Ideas.*
Although the wild animals listed are British rather than American, this book gives a lot of very useful information about housing and caring for mammals, reptiles, amphibians and insects.

_____. *Mammals in Classrooms: Teacher's Background Booklet.*
Discusses learning from observing classroom mammals. Such topics as inheritance, sense organs, growth, and behavior are covered.

Outdoor Biology Instructional Strategies (OBIS). Available from OBIS, Lawrence Hall of Science, University of California, Berkeley, CA 94720.

_____. *Lawn Guide* and *Pond Guide.* ($.60 each).
Useful for children identifying many of the common animals and plants found in each environment.

The Peterson Field Guide Series. Published by Houghton Mifflin Company.
Available at most book stores. These guides are more detailed than the Golden Nature Guides, and the text may be too difficult for students. However, teachers will find them helpful for identification, and students may find the excellent pictures useful. Titles useful to classes working on School Zoo include:

Conant, Roger, *A Field Guide to Reptiles and Amphibians*. Covers the Eastern United States. Also gives advice on catching, handling and caring for these animals.

Klots, Alexander, *A Field Guide to the Butterflies*.

Stebbins, Robert, *A Field Guide to Western Reptiles and Amphibians*. Also discusses capture and care.

Science Curriculum Improvement Study (SCIS). Available from Rand McNally & Company, Chicago.
These books are teachers' guides useful for classes keeping animals in the classroom. They describe animal growth, behavior, and interaction with environment.

Organisms	*Environments*
Life Cycles	*Communities*
Populations	*Ecosystems*

Snedigar, Robert, *Our Small Native Animals: Their Habits and Care*. ($2.50). Dover Publications, Inc., 180 Varick Street, New York, New York 10014.
A very useful inexpensive paperback, which describes many of the common mammals, reptiles and amphibians of North America, and gives advice on how to keep them in captivity.

Vancouver Environment Education Project. Write to Lesson Aids Service, B.C. Teacher's Foundation, 105-2235 Burrard Street, Vancouver 9, B.C., Canada.

_____. *A Mouse by Any Other Name*.
Describes commercially available live traps, and two ways to make your own. Very useful if you have escapees.

Resource Books for Children

Carthy, John. *Animal Camouflage*. New York: McGraw-Hill Book Co., 1974.
Basics of animal color change, mimicry, and other forms of camouflage. Useful for young children observing animal behavior.

Chinery, Michael. *Animal Communities*. New York: Franklin Watts, Inc., 1972.
For older children. Chapters on animal language, family life, ants, and bees may be useful to School Zoo classes.

DeWaard, E. John. *What Insect Is That?* Free. Xerox Corporation, 1965. Available from Xerox Education Center, Columbus, Ohio 43216.
This booklet is an identification guide for children. It has a simplified key for children to help classify common insects found for the zoo.

Elementary Science Study (ESS). Available from McGraw-Hill Book Co., Webster Division, Princeton Road, Hightstown, N.J.

_____. *Animal Activity - Experiments for Students*. ($1.59).
Discusses experiments children can do with animals on activity wheels.

_____. *The Curious Gerbils*. ($.75).
A helpful booklet devoted to gerbil care and behavior (4-6th grade level).

Ewbank, Constance. *Insect Zoo: How to Collect and Care for Insects*. ($4.50). New York: Walker & Co., Inc. 1973.
Describes how to capture and care for various insects. Intermediate level.

Golden Guides, Golden Press, New York. Very inexpensive and available at most book stores. They have many illustrations and children can use them to identify their animals by looking at the pictures. Titles include--

Butterflies & Moths	*Pond Life*
Fishes	*Reptiles & Amphibians*
Insects	*Spiders*

Ricciuti, Edward R. *Shelf Pets: How to Take Care of Small Wild Animals*. New York: Harper & Row, 1971.
Contains descriptions of wild animals commonly kept as pets--turtles, toads, spiders, crayfish, etc., as well as two domestic animals--hamsters and guinea pigs. Animal needs are discussed. Photographs excellent. Suitable for intermediate level students.

Roberts, Hortense Roberta. *You Can Make an Insect Zoo*. Chicago: Children's Press, 1974.
Description of simple cages for such insects as butterflies, crickets, and ants. Also describes some of the common insects children might find.

Russell, Solveig Paulson. *Like and Unlike: A First Look at Classification*. New York: Henry Z. Walck, Inc., 1973. ($4.95).
Basics of scientific method of classification (family, order, species, etc.). Useful for young children identifying animals in the zoo.

Silverstein, Alvin and Virginia. *Hamsters--All About Them*. New York: Lothrop, Lee & Shepard Company, 105 Madison Ave., 1974. ($5.50).
Hamster characteristics, habitats, and genetic background discussed. Useful section on selecting hamsters. Recommended for fifth graders and up. Authors have also written books on guinea pigs and mice.

Zappler, Georg E. and Lisbeth. *Amphibians as Pets*. Garden City, N.Y.: Doubleday & Company, Inc., 1973.
Describes evolutionary origins of amphibians, common types, and some basics of care. For older children.

Many pet stores sell small booklets about the care of specific animals, such as guinea pigs, hamsters, guppies and goldfish. These may be useful resources for students.

Sources of Live Food and Other Biological Materials

If you cannot catch live insects to feed your animals, and cannot raise a breeding colony of houseflies, try your local petshop for mealworms. Bait stores may have other live insects, and the biology departments of either a college or high school may supply your class with houseflies, fruitflies, mealworms or other insects. If all else fails, biological supply houses will be able to

provide you with starter colonies of many invertebrates, but this will cost more.

Eastern U.S.	Western U.S.
Carolina Biological Supply Co. Burlington, N.C. 27215 919/584-3711	Powell Laboratories Gladstone, OR 97027 503/656-1461
Ward's Natural Science Establishment Inc. P.O. Box 1712 Rochester, N.Y. 14603	Ward's of California P.O. Box 1749 Monterey, CA 93940

Carolina Biological Supply and its sister firm on the west coast, Powell Labs, are both very reliable and easy to work with. A request on school stationery will get you a free catalog.

4. GLOSSARY

The following definitions may be helpful to a teacher whose class is investigating a School Zoo challenge. Some of the words are included to give the teacher an understanding of technical terms; others are included because they are commonly used throughout the resource book.

These terms may be used when they are appropriate for the children's work. For example, a teacher may tell the children that when they measure weights of animals, they are collecting *data*. It is not necessary for the teacher or students to learn the definitions nor to use all of the terms while working on their challenge. Rather, the children will begin to use the words and understand the meanings as they become involved in their investigations.

Algae	Small, single-celled plants, usually aquatic, that contain chlorophyll and are often found in colonies (e.g., seaweed, pond scum).
Amphibian	A cold-blooded vertebrate with non-scaly skin whose young are usually aquatic. Examples: frogs, toads, salamanders.
Aquarium	A container filled with water in which aquatic animals and plants are kept.
Average	The numerical value obtained by dividing the sum of the elements of a set of data by the number of elements in that set, e.g., the average weight of the baby guinea pigs in the zoo. Also called the mean.
Bias	A deviation in the expected values of a set of data, often occurring when some factor produces one outcome more frequently than others.
Bird	A feathered, warm-blooded animal which has wings (or rudiments of wings) and reproduces by laying eggs.
Calibration	Setting and marking an instrument to correspond to standard measurements.
Carnivore	An animal that feeds on other animals. Examples: toads, spiders. Also, an insect-eating plant.

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Cold-blooded Animals	Animals having a body temperature not internally regulated but approximating that of their environment. Examples: invertebrates, fish, reptiles, amphibians.
Colony	A group of animals or plants of the same kind (e.g., ants, termites, bees) that live and often work together.
Community	An interacting population of various kinds of plants and animals living in the same area.
Comparative Shopping	A method for determining the best buy(s) by comparing the costs, quantities, and qualities of different brands of products.
Complement of a Set	See *Set*.
Conversion	A change from one form to another. Generally associated in mathematics and science with the change from one unit of measure to another or the change from one form of energy to another.
Correlation	A relationship between two sets of data.
Cost	The amount of money needed to produce or to purchase goods or services.
Crustacean	A water animal with a hard outside covering. Examples: shrimp, crayfish, lobster.
Data	Any facts, quantitative information, or statistics.
Degree	A unit of measurement of temperature or angle.
Discount	A reduction in the price or services, often stated as a percentage of price. This is done (1) for customers who buy in large quantities or (2) in order to generate a greater volume of sales.
Distribution	The spread of data over the range of possible results.
Ecosystem	The interaction between plants and animals and their environment in a certain locality.
Edit	To collect and arrange materials into a finished publication or program.

Environment — The conditions in which an organism lives, including temperature, light, water, and other organisms.

Event — A happening; an occurrence; something that takes place. Example: an animal successfully solving a problem, such as running a maze.

Fish — A cold-blooded vertebrate that lives in the water and breathes by using gills, e.g., goldfish, guppy.

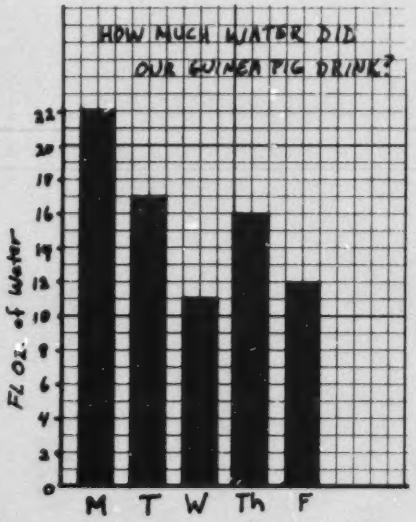
Force — A push or a pull.

Frequency — The number of times a certain event occurs in a given unit of time or in a given total number of events.

Graph — A drawing or a picture of one or several sets of data.

Bar Graph — A graph of a set of measures or counts whose sizes are represented by the vertical (or horizontal) lengths of bars of equal widths or lines. Example: the number of fluid ounces of water a guinea pig drinks each day of the week.

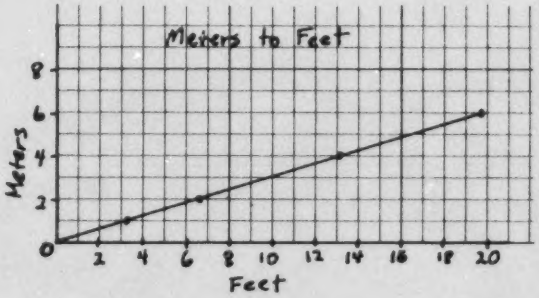
Day	Fl. Oz. Water
Monday	22
Tuesday	17
Wednesday	11
Thursday	16
Friday	12



Conversion Graph

A line graph that is used to change one unit of measurement to another. For example, changing meters to feet when buying lumber for cages.

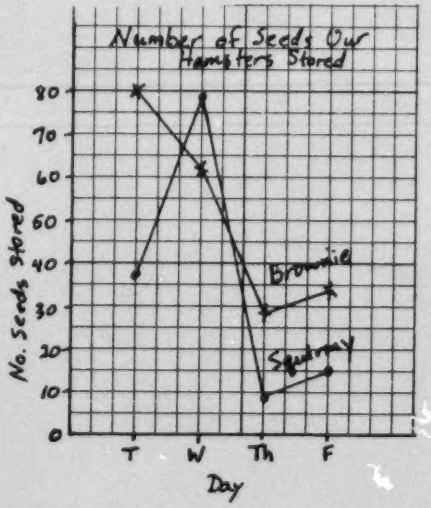
Meters	Feet
1	3.3
2	6.6
4	13.1
6	19.7



Line Chart

A bar graph that is represented by circles, triangles, or crosses with lines connecting them so that it has the appearance of a line graph. (See *Line Graph*.) This is a useful representation when two or more sets of data are shown on the same graph. Example: the number of seeds different hamsters stored on different days.

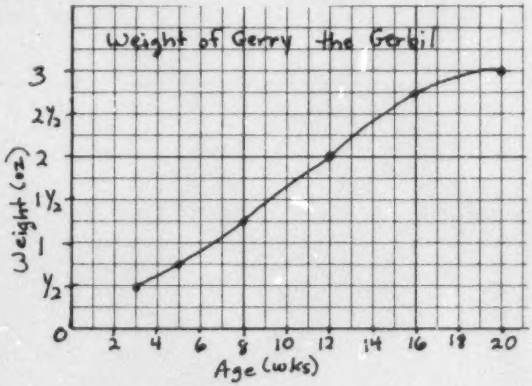
	Number of seeds stored			
Hamster	Tues.	Wed.	Thurs.	Fri.
Brownie	80	62	28	33
Squirmy	37	78	9	15



Line Graph

A graph in which a smooth line or line segments pass through or near points representing members of a set of data. Since the line represents an infinity of points, the variable on the horizontal axis must be continuous. If the spaces between the markings on the horizontal axis have no meaning, then the graph is not a line graph, but a line chart (see *Line Chart*.) Example: the weight of a young gerbil at different ages.

Age (wks)	Weight (oz)
3	1/2
5	3/4
8	1 1/4
12	2
16	2 3/4
20	3

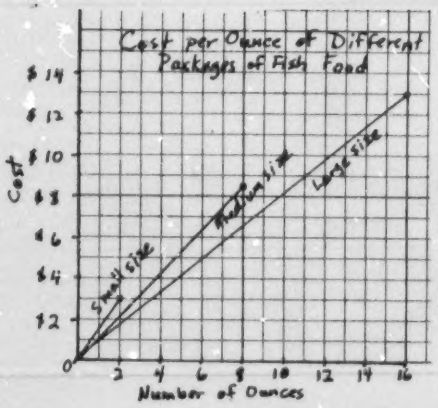


*Slope Diagram**

A graphical means of comparing fractions or ratios. To represent the ratio a/b, plot the point (b,a) and draw a line from (b,a) to the origin (0,0). The slope of this line represents the ratio a/b. By comparing slopes of several lines, different ratios can be compared; the less steep the line, the smaller the ratio. For example, the diagram on the next page shows the ratio of price to weight for different sized packages of fish food. The ratio of price to weight for the large size is smaller than that for the medium and small sizes, and therefore, the large size costs the least per ounce.

*Formerly called Triangle Diagram.

Size	Weight	Price
Small	2 oz.	$2.99
Medium	8 oz.	$8.49
Large	16 oz.	$12.99



Habitat — The place or type of environment in which an organism lives.

Herbivore — A plant-eating animal. Examples: gerbils, caterpillars.

Heredity — The transmission of qualities from one generation to another.

Hibernation — The state of inactivity in which many animals pass the winter.

Hypothesis — A tentative conclusion made in order to test its implications or consequences.

Inference — An assumption derived from facts or information considered to be valid and accurate.

Insect — An animal with three pairs of legs and three distinct parts of the body: head, thorax, abdomen. Examples: butterfly, cricket, grasshopper.

Intersection of Sets — See *Set*.

Inventory — The quantity of goods or materials on hand.

Invertebrate — An animal without a backbone. Examples: worms, snails, insects, spiders, crayfish.

Key — An arrangement of the important physical characteristics of animals or plants designed to facilitate the identification of an unknown type.

Life Cycle	The series of stages through which an organism passes during its life.
Mammal	Any warm-blooded animal that has hair and suckles its young. Examples: guinea pig, human being.
Matrix	A chart of data arranged in rows and columns.
Mean	See *Average*.
Median	The middle value of a set of data in which the elements have been ordered from smallest to largest, e.g., median weight of guinea pigs. The median value has as many elements above it as below it.
Medium, pl. Media	A means of communication. Examples: publication, television, radio.
Metabolism	The process by which an organism transforms food to energy and waste.
Microorganism	An organism that is too small to be seen with the naked eye but can be seen through a microscope. Examples: amoebae, bacteria, some types of algae.
Mineral	Nutritionally, a simple, inorganic chemical that animals need in small quantities for body structure or chemical processes within the body. Minerals are commonly found in food substances.
Mode	The element or elements in a set of data that occur most often.
Nutrient	Any chemical substance (found in food or soil) necessary for an organism's life and growth.
Omnivore	An animal that feeds on both plants and animals. Example: humans, some turtles.
Ordered Set	A set of data arranged from smallest to largest.
Organism	A living entity. Example: any plant or animal.
Parasite	An organism that depends on another living organism for food or support without giving anything beneficial in return. Example: lice, worms.

Per Cent	Literally per hundred. A ratio in which the denominator is always 100, e.g., 72 per cent = 72/100 = 0.72 = 72% , where the symbol % represents 1/100.
Percentage	A part of a whole expressed in hundredths.
Predator	An animal that lives by killing and eating other animals.
Probability	The likelihood or chance (expressed numerically) of one event occurring out of several possible events.
Proportion	A statement of equality of two ratios, i.e., the first term divided by the second term equals the third term divided by the fourth term, e.g., 5/10 = 1/2. Also a synonym for ratio: when two quantities are in direct proportion, their ratios are the same.
Range	Mathematical: The difference between the smallest and the largest values in a set of data. Biological: a region throughout which a type of organism or ecosystem naturally occurs.
Rank	To order the members of a set according to some criterion, such as size or importance. Example: to put pieces of data from smallest to largest.
Ratio	The quotient of two denominate numbers or values indicating the relationship in quantity, size, or amount between two different things. For example, the ratio of the cost of a box of fish food compared to length of time it lasts might be $1.19/3 weeks, or $1.19:3 weeks.
Reproduction	The process by which organisms form new organisms of their own kind.
Reptile	Any cold-blooded, air-breathing vertebrate with scaly skin. Examples: snake, turtle, lizard.
Rodent	A small, gnawing mammal with large front teeth that grow continuously. Examples: rat, mouse, hamster, guinea pig, gerbil.
Set	A collection of characteristics, persons, or objects. Each thing in a set is called a member or an element.
Set Theory	The branch of mathematics that deals with the nature and relations of sets.

Complement of a Set	The set of all elements in the universal set but not in the given set. For example, if the universal set is the set of all animals in the zoo, then the set of amphibians is the complement of the set of mammals.
Intersection of Sets	The set of elements common to two or more sets. For example, if set A is all vertebrates in the zoo and set B is all carnivores, the intersection of set A and set B is the set of carnivorous vertebrates (toads, snakes, lizards) in the zoo.
Universal Set	A set that contains all elements relevant to a particular problem.
Venn Diagram	A drawing used to illustrate the relationship between sets.
Slope Diagram	See *Graph*.
Species	A category of scientific classification referring to a group of organisms that look alike and can interbreed.
Speed	A measure of how fast something is moving. The distance covered divided by the elapsed time.
Statistics	The science of drawing conclusions or making predictions using a collection of quantitative data.
Tally	A visible record used to keep a count of some set of data, especially a record of the number of times one or more events occur. Example: the number of times a guinea pig finds its way to its own cage during an experiment.
Temperature	A measure of hotness or coldness. Technically, an indication of the average kinetic energy of molecules. Temperature is commonly measured in degrees Fahrenheit or degrees centigrade (Celsius).
Terrarium	A container, partially filled with earth or sand, in which plants and sometimes animals are kept.
Thermometer, Celsius	A thermometer on which the interval between the normal freezing and boiling points of water is divided into 100 parts or degrees, ranging from $0^{\circ}C$ to $100^{\circ}C$.
Thermometer, Fahrenheit	A thermometer on which the interval between the normal freezing and boiling points of water is divided into 180 parts or degrees, ranging from $32^{\circ}F$ to $212^{\circ}F$.

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Vertebrate	Any animal with a backbone. Examples: fish, amphibian, reptile, bird, mammal.
Vitamin	A complex organic substance that an animal usually cannot make internally but that is necessary in small quantities for chemical processes within the body.
Warm-blooded Animals	Animals having a relatively high and constant body temperature that is relatively independent of the surrounding temperature. Examples: birds, mammals.
Work	Work is done when a force is exerted through a distance. Work is the product of the force exerted and the distance moved.

E. Skills, Processes, and Areas of Study Utilized in School Zoo

The unique aspect of USMES is the degree to which it provides experience in the process of solving real problems. Many would agree that this aspect of learning is so important as to deserve a regular place in the school program even if it means decreasing to some extent the time spent in other important areas. Fortunately, real problem solving is also an effective way of learning many of the skills, processes, and concepts in a wide range of school subjects.

On the following pages are five charts and an extensive, illustrative list of skills, processes, and areas of study that are utilized in USMES. The charts rate School Zoo according to its potential for learning in various categories of each of five subject areas--real problem solving, mathematics, science, social science, and language arts. The rating system is based on the amount that each skill, process, or area of study within the subject areas is used--extensive (1), moderate (2), some (3), little or no use (-). (The USMES Guide contains a chart that rates all USMES units in a similar way.)

The chart for real problem solving presents the many aspects of the problem-solving process that students generally use while working on an USMES challenge. A number of the steps in the process are used many times and in different orders, and many of the steps can be performed concurrently by separate groups of students. Each aspect listed in the chart applies not only to the major problem stated in the unit challenge but also to many of the tasks each small group undertakes while working on a solution to the major problem. Consequently, USMES students gain extensive experience with the problem-solving process.

The charts for mathematics, science, social science, and language arts identify the specific skills, processes, and areas of study that may be learned by students as they respond to a School Zoo challenge and become involved with certain activities. Because the students initiate the activities, it is impossible to state unequivocally which activities will take place. It is possible, however, to document activities that have taken place in USMES classes and identify those skills and processes that have been used by the students.

Knowing in advance which skills and processes are likely to be utilized in School Zoo and knowing the extent that they will be used, teachers can postpone the teaching

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of those skills in the traditional manner until later in the year. If the students have not learned them during their USMES activities by that time, they can study them in the usual way. Further, the charts enable a teacher to integrate USMES more readily with other areas of classroom work. For example, teachers may teach fractions during math period when fractions are also being learned and utilized in the students' USMES activities. Teachers who have used USMES for several successive years have found that students are more motivated to learn basic skills when they have determined a need for them in their USMES activities. During an USMES session the teacher may allow the students to learn the skills entirely on their own or from other students, or the teacher may conduct a skill session as the need for a particular skill arises.

Because different USMES units have differing emphases on the various aspects of problem solving and varying amounts of possible work in the various subject areas, teachers each year might select several possible challenges, based on their students' previous work in USMES, for their class to consider. This choice should provide students with as extensive a range of problems and as wide a variety of skills, processes, and areas of study as possible during their years in school. The charts and lists on the following pages can also help teachers with this type of planning.

Some USMES teachers have used a chart similar to the one given here for real problem solving as a record-keeping tool, noting each child's exposure to the various aspects of the process. Such a chart might be kept current by succeeding teachers and passed on as part of a student's permanent record. Each year some attempt could be made to vary a student's learning not only by introducing different types of challenges but also by altering the specific activities in which each student takes part. For example, children who have done mostly construction work in one unit may be encouraged to take part in the data collection and data analysis in their next unit.

Following the rating charts are the lists of explicit examples of real problem solving and other subject area skills, processes, and areas of study learned and utilized in School Zoo. Like the charts, these lists are based on documentation of activities that have taken place in USMES classes. The greater detail of the lists allows teachers to see exactly how the various basic skills, processes, and areas of study listed in the charts may arise in School Zoo.

The number of examples in the real problem solving list have been limited because the list itself would be unreasonably long if all the examples were listed for some of the categories. It should also be noted that the example(s) in the first category--*Identifying and Defining Problems*--have been limited to the major problem that is the focus of the unit. During the course of their work, the students will encounter and solve many other, secondary problems, such as the problem of how to display their data or how to draw a scale layout.

Breaking down an interdisciplinary curriculum like USMES into its various subject area components is a difficult and highly inexact procedure. Within USMES the various subject areas overlap significantly, and any subdivision must be to some extent arbitrary. For example, where does measuring as a mathematical skill end and measurement as science and social science process begin? How does one distinguish between the processes of real problem solving, of science, and of social science? Even within one subject area, the problem still remains--what is the difference between graphing as a skill and graphing as an area of study? This problem has been partially solved by judicious choice of examples and extensive cross-referencing.

Because of this overlap of subject areas, there are clearly other outlines that are equally valid. The scheme presented here was developed with much care and thought by members of the USMES staff with help from others knowledgeable in the fields of mathematics, science, social science, and language arts. It represents one method of examining comprehensively the scope of USMES and in no way denies the existence of other methods.

REAL PROBLEM SOLVING	Overall Rating
Identifying and defining problem.	1
Deciding on information and investigations needed.	1
Determining what needs to be done first, setting priorities.	1
Deciding on best ways to obtain information needed.	1
Working cooperatively in groups on tasks.	2
Making decisions as needed.	1
Utilizing and appreciating basic skills and processes.	1
Carrying out data collection procedures--observing, surveying, researching, measuring, classifying, experimenting, constructing.	1
Asking questions, inferring.	1
Distinguishing fact from opinion, relevant from irrelevant data, reliable from unreliable sources.	1

REAL PROBLEM SOLVING	Overall Rating
Evaluating procedures used for data collection and analysis. Detecting flaws in process or errors in data.	1
Organizing and processing data or information.	1
Analyzing and interpreting data or information.	1
Predicting, formulating hypotheses, suggesting possible solutions based on data collected.	1
Evaluating proposed solutions in terms of practicality, social values, efficacy, aesthetic values.	1
Trying out various solutions and evaluating the results, testing hypotheses.	1
Communicating and displaying data or information.	1
Working to implement solution(s) chosen by the class.	1
Making generalizations that might hold true under similar circumstances; applying problem-solving process to other real problems.	1

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use

MATHEMATICS	Overall Rating
Basic Skills	
Classifying/Categorizing	1
Counting	1
Computation Using Operations	
Addition/Subtraction	2
Multiplication/Division	1
Fractions/Ratios/Percentages	2
Business and Consumer Mathematics/ Money and Finance	2
Measuring	1
Comparing	1
Estimating/Approximating/Rounding Off	1
Organizing Data	1
Statistical Analysis	3
Opinion Surveys/Sampling Techniques	-
Graphing	3
Spatial Visualization/Geometry	3
Areas of Study	
Numeration Systems	2
Number Systems and Properties	2
Denominate Numbers/Dimensions	1
Scaling	-
Symmetry/Similarity/Congruence	-
Accuracy/Measurement Error/ Estimation/Approximation	1
Statistics/Random Processes/Probability	3
Graphing/Functions	3
Fraction/Ratio	2
Maximum and Minimum Values	-
Equivalence/Inequality/Equations	2
Money/Finance	2
Set Theory	2

SCIENCE	Overall Rating
Processes	
Observing/Describing	1
Classifying	1
Identifying Variables	3
Defining Variables Operationally	3
Manipulating, Controlling Variables/ Experimenting	2
Designing and Constructing Measuring Devices and Equipment	1
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	1
Measuring/Collecting, Recording Data	1
Organizing, Processing Data	1
Analyzing, Interpreting Data	1
Communicating, Displaying Data	1
Generalizing/Applying Process to New Problems	1
Areas of Study	
Measurement	1
Motion	-
Force	3
Mechanical Work and Energy	3
Solids, Liquids, and Gases	2
Electricity	-
Heat	2
Light	3
Sound	3
Animal and Plant Classification	1
Ecology/Environment	1
Nutrition/Growth	1
Genetics/Heredity/Propagation	1
Animal and Plant Behavior	1
Anatomy/Physiology	2

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use

SOCIAL SCIENCE	Overall Rating
Process	
Observing/Describing/Classifying	2
Identifying Problems, Variables	1
Manipulating, Controlling Variables/ Experimenting	3
Inferring/Predicting/Formulating, Testing Hypotheses	3
Collecting, Recording Data/Measuring	-
Organizing, Processing Data	-
Analyzing, Interpreting Data	-
Communicating, Displaying Data	-
Generalizing/Applying Process to Daily Life	3
Attitudes/Values	
Accepting responsibility for actions and results	1
Developing interest and involvement in human affairs	1
Recognizing the importance of individual and group contributions to society	1
Developing inquisitiveness, self-reliance, and initiative	1
Recognizing the values of cooperation, group work, and division of labor	1
Understanding modes of inquiry used in the sciences, appreciating their power and precision	1
Respecting the views, thoughts, and feelings of others	1
Being open to new ideas and information	1
Learning the importance and influence of values in decision making	1
Areas of Study	
Anthropology	-
Economics	3
Geography/Physical Environment	3
Political Science/Government Systems	3
Recent Local History	-
Social Psychology/Individual and Group Behavior	3
Sociology/Social Systems	-

LANGUAGE ARTS	Overall Rating
Basic Skills	
Reading	
Literal Comprehension: Decoding Words, Sentences, Paragraphs	1
Critical Reading: Comprehending Meanings, Interpretation	1
Oral Language	
Speaking	1
Listening	1
Memorizing	-
Written Language	
Spelling	2
Grammar: Punctuation, Syntax, Usage	2
Composition	2
Study Skills	
Outlining/Organizing	1
Using References and Resources	2
Attitudes/Values	
Appreciating the value of expressing ideas through speaking and writing	1
Appreciating the value of written resources	1
Developing an interest in reading and writing	1
Making judgments concerning what is read	1
Appreciating the value of different forms of writing, different forms of communication	1

KEY: 1 = extensive use, 2 = moderate use, 3 = some use, - = little or no use

REAL PROBLEM SOLVING IN SCHOOL ZOO

Identifying and Defining Problems	• Students decide that their school needs a zoo, where children can observe and learn about animals.
Deciding on Information and Investigations Needed	• After a discussion students decide to collect small animals and keep them in the classroom. • Students decide to experiment with food, bedding, and materials for cages to find out which kinds are best for their animals. • Students decide that they need to research more information about animals by reading library books.
Determining What Needs to Be Done First, Setting Priorities	• Students decide to plan for animal care first before obtaining the animals. • Children decide to research information about animals first before showing them to other children. • Children decide to keep animals in plastic cages or cardboard boxes while building permanent cages.
Deciding on Best Ways to Obtain Information Needed	• Students decide that each animal should be cared for by a different small group so that there won't be too many people working with any one animal. • Students call or visit different pet stores to compare prices on animals, food, bedding, and homes. • Students experiment to find out which materials for cages rodents can chew. • Children conduct preference tests to find out different animals' favorite foods. • Students decide to research information on animals by reading library books.
Working Cooperatively in Groups on Tasks	• Students form groups to collect, to care for, and to research information on different animals.
Making Decisions as Needed	• Students decide to work in groups so that more can be accomplished. • Students decide to build homes for some animals (rodents) but to purchase homes for others (fish). • Children decide to make cages out of wood because Tri-Wall is too easy for rodents to chew.

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Making Decisions as Needed (cont.)	• Students decide to purchase foods for animals that they seem to prefer. • Students decide to add more animals to their zoo to increase its variety. • Students decide that holding an Open House will be the best way to show the zoo to the rest of the school.
Utilizing and Appreciating Basic Skills and Processes	• Students measure wood, screening, etc., when making cages for animals. • Students identify small animals collected outside. • Students use voting procedures to make decisions about the zoo. • Students write pamphlets and talk about animals in the zoo to other children. • See also MATHEMATICS, SCIENCE, SOCIAL SCIENCE, and LANGUAGE ARTS lists.
Carrying Out Data Collection Procedures--Opinion Surveying, Researching, Measuring, Classifying, Experimenting, Constructing	• Children conduct experiments to find nonchewable cage materials, favorite foods of animals, etc. • Students measure amounts of food and water animals consume. • Students measure the growth of young animals. • Students look up information on animals in library books. • Students construct cages from wood, screening, Tri-Wall, etc. • See also MATHEMATICS list: *Classifying/Categorizing; Measuring.* • See also SCIENCE list: *Observing/Describing; Classifying; Manipulating, Controlling Variables/Experimenting; Designing and Constructing Measuring Devices and Equipment; Measuring/Collecting, Recording Data.* • See also SOCIAL SCIENCE list: *Observing/Describing; Classifying; Manipulating, Controlling Variables/Experimenting; Collecting, Recording Data/Measuring.*
Asking Questions, Inferring	• Students ask whether different animals respond differently to toys, other animals, new places, etc. They infer from observations that they do. • Students ask which animals they should keep in their zoo. They infer that animals that are inexpensive to buy and adaptable to captivity would be best. • Students ask what kinds of food their toads will eat. They infer from experimentation that they will eat only living insects.

Asking Questions, Inferring (cont.)	• Students ask whether Tri-Wall is suitable for a gerbil cage and infer from watching the gerbils chew up cardboard that it is not suitable. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.* • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Distinguishing Fact from Opinion, Relevant from Irrelevant Data, Reliable from Unreliable Sources	• Students recognize that many superstitions about animals (e.g., toad giving warts) are not borne out by factual observation. • Students recognize that pet store owners may be good sources of information on fish and rodents.
Evaluating Procedures Used for Data Collection and Analysis, Detecting Flaws in Process or Errors in Data	• Students evaluate the manner in which amount of food or water consumed, growth of animals, etc., were measured. • Students discuss ways in which food or bedding preferences and durability of materials for cages were tested. • Students discuss ways to observe animals or research information on them. • See also MATHEMATICS list: *Estimating/Approximating/Rounding Off.*
Organizing and Processing Data	• Students record growth of animals on a line graph. • Students make a bar graph showing amounts of food or water an animal consumes each day. • See also MATHEMATICS list: *Organizing Data.* • See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data.*
Analyzing and Interpreting Data	• Students decide from results of experiments that Plexiglas is the safest construction material for making a gerbil cage. • Students find the food or foods an animal prefers the most often (mode). • Students calculate the average amount of food and water consumed daily. • Students find the average growth over a certain period of time of animals in a litter. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing.* • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data.*

Predicting, Formulating Hypotheses, Suggesting Possible Solutions Based on Data Collected	• Students hypothesize that their guinea pig's favorite food is lettuce. • After observing students decide that adult male hamsters are not compatible and should be kept in separate cages. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.* • See also SOCIAL SCIENCE list: *Inferring/Predicting/ Formulating, Testing Hypotheses.*
Evaluating Proposed Solutions in Terms of Practicality, Social Values, Efficacy, Aesthetic Values	• Students making a zoo consider cost, amount of care, comfort of animals, cleanliness of animals, etc., before choosing animals to include. • Students consider whether or not wild animals kept in the zoo should be released at the end of the year or kept in captivity.
Trying Out Various Solutions and Evaluating the Results, Testing Hypotheses	• Students experiment with different foods, different homes, and different beddings to find out which ones the animal seems to prefer. • Students experiment to find out which animals are compatible. • Students try out different ways of sharing feeding and cage cleaning tasks. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses/Modeling.* • See also SOCIAL SCIENCE list: *Inferring/Predicting/ Formulating, Testing Hypotheses.*
Communicating and Displaying Data or Information	• Students make a line graph showing amounts of food or water consumed each day. • Students make a line graph showing average growth rate of young guinea pigs. • Students make sketches of cage designs. • Students make pamphlets explaining information about animals. • See also MATHEMATICS list: *Graphing, Scaling.* • See also SCIENCE and SOCIAL SCIENCE lists: *Communicating, Displaying Data.* • See also LANGUAGE ARTS list.
Working to Implement Solution(s) Chosen by the Class	• Students present the zoo to other classes through an Open House.

Making Generalizations That Might Hold True Under Similar Circumstances; Applying Problem-Solving Process to Other Real Problems

- Students working on School Zoo apply skills they have acquired to Nature Trails.
- Students use construction skills developed while making cages for making other things needed in the school.
- See also SCIENCE list: *Generalizing/Applying Process to New Problems.*
- See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*

ACTIVITIES IN SCHOOL ZOO UTILIZING MATHEMATICS

Basic Skills

Classifying/Categorizing	• Categorizing characteristics of animals and habitats. • Using the concepts and language of sets (subsets, unions, intersections, set notation) for discussing animal classification. • See also SCIENCE list: *Classifying*. • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying*.
Counting	• Counting votes and decisions made about the zoo. • Counting number of animals, number of seeds eaten, number of fluid ounces, etc., while collecting data. • Counting to read scales on measuring instruments, such as meter stick, thermometer. • Counting by sets to find scale for graph axes.
Computation Using Operations: Addition/Subtraction	• Adding one-, two-, or three-digit whole numbers to find total tally, such as number of seeds stored, or total measurement, such as total amount of water consumed during a certain period. • Subtracting to find differences between predicted and actual measurements, such as food consumption over a weekend. • Subtracting one-, two-, or three-digit whole numbers to find ranges for graph axes or for measurement data or to compare sets of data. • Subtracting to find growth of animals over a certain period of time.
Computation Using Operations: Multiplication/Division	• Multiplying whole numbers to find area or volume of cages and aquaria. • Multiplying or dividing to find scale for graph axes. • Multiplying or dividing to convert from meters to feet, Celsius to Fahrenheit, or vice versa. • Dividing to calculate average weight, average growth rate, average amount of food consumed. • Dividing to calculate ratios, fractions, or percentages.

Computation Using Operations: Fractions/Ratios/Percentages	• Using mixed numbers to perform calculations, such as totaling food or water consumption for a given time period. • Changing fractions to higher or lower terms (equivalent fractions) to perform operations such as addition, subtraction of animal sizes or weights to calculate growth. • Using fractions or decimals in measurement, graphing, or graphic comparisons. • Calculating ratios or percentages from food preference test data. • Calculating growth rate over a certain period of time. • Using slope diagrams to compare ratios of animal food prices to quantity of food for different sized packages. • Calculating percentages of animals of each color in a litter (to observe genetic characteristics). • Using proportions to increase or decrease ingredients in a food mixture.
Computation Using Operations: Business and Consumer Mathematics/ Money and Finance	• Investigating costs of animals, food, and cage materials for the zoo vs. budget restrictions. • Adding, subtracting, multiplying, and dividing to perform cost analysis for constructing cages or maintaining the zoo.
Measuring	• Converting from inches to feet, meters to feet, etc. • Using different standard units of measure to measure temperature of animal homes, sizes of cages, weights of animals. • Reading measuring devices accurately when measuring temperature of homes, weights of animals, length of wood for cages. • See also SCIENCE list: *Measuring/Collecting, Recording Data*. • See also SOCIAL SCIENCE list: *Collecting, Recording Data/Measuring*.
Comparing	• Using the concept of "greater than" and "less than" in comparing numbers or sizes of animals. • Comparing qualitative information on animal behavior gathered from library research with information obtained from observations. • Comparing information from library research on animal eating habits with quantitative data obtained from food preference experiments.

Comparing (cont.)	• Comparing estimated and actual results of measurements or counts. • Making graphic comparisons of ratios, such as animal growth rates or unit prices of animal foods. • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data*.
Estimating/Approximating/ Rounding Off	• Estimating amount of food or water an animal will consume on a weekend. • Estimating amounts of materials needed for cage construction. • Determining when a measurement is likely to be accurate enough for a particular purpose (e.g., cage construction). • Rounding off measurements when measuring length, weight, or temperature. • Rounding off measurements after measuring length, weight, or temperature.
Organizing Data	• Making charts of animal characteristics, behavior, etc. • Tallying on bar graphs. • Ordering numbers on a graph axis. • Ordering the steps in a process. • Ordering results of food preference tests. • Ordering meters, grams, or degrees on a thermometer. • See also SCIENCE and SOCIAL SCIENCE lists: *Organizing, Processing Data*.
Statistical Analysis	• Finding the average growth rate for certain animals or the average amount of food and water consumed. • Taking repeated measurements of animal size or weight and using the median measurement. • Determining the range of animal sizes, amount of food or water consumed. • See also SCIENCE and SOCIAL SCIENCE lists: *Analyzing, Interpreting Data*.
Graphing	• Using alternative methods of displaying data on animal food preferences, growth rates, etc. • Making a graph form--dividing axes into parts, deciding on an appropriate scale.

Graphing (cont.)	• Representing data on graphs.
	  • Bar graph--plotting amount of different foods eaten or sizes of different animals.
	  • Conversion graph--for converting degrees Fahrenheit to degrees Celsius to find correct temperature for animal's habitat.
	  • Line graph--plotting weight of a young animal each week.
	  • Line chart--plotting amount of food eaten for different animals on different days.
	  • Slope diagram--cost vs. quantity of different brands or different sizes of animal foods.
	• See also SCIENCE and SOCIAL SCIENCE lists: *Communicating, Displaying Data*.

Spatial Visualization/Geometry	• Constructing and using geometric figures, e.g., circles, when making cages. • Using geometric figures to understand and utilize relationships, such as area, volume (of cages and aquaria). • Using standard mensurational formulas, e.g., Area = Length x Width. • Measuring and constructing cages using measuring devices. • Using spatial arrangement of animal cages to convey information to visitors.
Areas of Study	
Numeration Systems	• Using metric system (decimal) in measuring distances. • Using fractions in measuring feet. • Using decimal system in calculating costs of animals, food, and construction materials.
Number Systems and Properties	• See *Computation Using Operations*.
Denominate Numbers/Dimensions	• See *Measuring*.
Symmetry/Similarity/Congruence	• See *Spatial Visualization/Geometry*.
Accuracy/Measurement Error/ Estimation/Approximation	• See *Measuring* and *Estimating/Approximating/Rounding Off*.

Statistics/Random Processes/ Probability	• See *Statistical Analysis*.
Graphing/Functions	• See *Graphing*.
Fraction/Ratios	• See *Computation Using Operations: Fractions/Ratios/ Percentages*.
Equivalence/Inequality/Equations	• See *Comparing* and *Computation Using Operations*.
Money/Finance	• See *Computation Using Operations: Business and Consumer Mathematics/Money and Finance*.
Set Theory	• See *Classifying/Categorizing*.

ACTIVITIES IN SCHOOL ZOO UTILIZING SCIENCE

Process	
Observing/Describing	• Observing and describing various things about animals, e.g., behavior, interactions, physical characteristics. • Describing the zoo and animals in it to others. • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying.*
Classifying	• Classifying animals according to physical characteristics, e.g., warm-blooded vs. cold-blooded, herbivore/canivore. • Categorizing information about animals, e.g., behavior, physical characteristics, diet, that can be presented to others. • See also MATHEMATICS list: *Classifying/Categorizing.* • See also SOCIAL SCIENCE list: *Observing/Describing/Classifying.*
Identifying Variables	• Identifying food consumption, water consumption, amount and type of activity as things to observe in order to tell if an animal is healthy. • Identifying amount of water, amount of warmth (i.e., temperature), amount of space per animal, as variables to be controlled before conducting a food preference test on healthy animals. • Identifying type of food as the variable to be changed when experimenting with food preference. • See also SOCIAL SCIENCE list: *Identifying Problems, Variables.*
Defining Variables Operationally	• Defining amount of warmth as the temperature measured by a thermometer in degrees Celsius (or Fahrenheit) inside an animal's home. • Defining amount of water consumed as the total amount an animal drinks during a 24-hour period. • Defining types of foods as foods selected from those food groups that are nutritionally good for the animals being treated. • Defining amount and type of activity as that activity observed and recorded in daily logs as typically active, sluggish, aggressive, playful, etc.

Manipulating, Controlling Variables/Experimenting	• Designing and controlling an experiment to determine which type of food(s) an animal prefers. • Keeping water, space, temperature, and health of an animal the same while experimenting with food preferences. • Making a zoo that includes a variety of animals. • Experimenting to learn about animal behavior: reaction to humans, other animals, strange environments, objects, etc. • See also SOCIAL SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Designing and Constructing Measuring Devices and Equipment	• Designing and constructing homes for animals, insect traps, or traps for animals that have escaped in the classroom.
Inferring/Predicting/Formulating, Testing Hypotheses/Modeling	• Inferring on the basis of food preference tests that a given guinea pig prefers lettuce to carrots and celery. • Inferring from watching behavior of hamsters that they will be happier in separate cages. • Predicting color and markings of baby rodents based on appearance of the parents. • Hypothesizing that the disappearance of baby toads is due to the presence of the leopard frog in the same container; taking the leopard frog out and finding that this is so. • Modeling a large zoo by collecting a variety of animals. • See also SOCIAL SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*
Measuring/Collecting, Recording Data	• Giving an animal the choice of several foods; recording which food the animal eats first each time. • Collecting data on animals by daily observation. • Weighing animals to determine growth rates. • Measuring amounts of food and water consumed by animals. • Researching information on animals and animal care from library books. • Measuring to construct cages or collecting devices. • See also MATHEMATICS list: *Measuring.* • See also SOCIAL SCIENCE list: *Collecting, Recording Data/Measuring.*
Organizing, Processing Data	• Making charts and graphs of data. • Organizing data from library research and experiments on animal characteristics and behavior.

Organizing, Processing Data (cont.)	• Ordering size of animals from smallest to largest. • See also MATHEMATICS list: *Organizing Data.* • See also SOCIAL SCIENCE list: *Organizing, Processing Data.*
Analyzing, Interpreting Data	• Determining which food an animal prefers from the results of food preference tests. • Calculating growth rates from periodic weights of young animals. • Calculating average or median amount of food or water consumed each day. • Determining that two animals are compatible or incompatible from the results of observations. • Determining from research that the zoo contains a wide variety of animals. • Interpreting graphs. • See also MATHEMATICS list: *Comparing; Statistical Analysis; Opinion Surveys/Sampling Techniques; Graphing.* • See also SOCIAL SCIENCE list: *Analyzing, Interpreting Data.*
Communicating, Displaying Data	• Showing data on various types of graphs and charts. • Showing ideas for cages on sketches. • Showing information about animals on displays or in pamphlets for people visiting the zoo. • Demonstrating facts about animal behavior through experiments with animals during an Open House. • See also MATHEMATICS list: *Graphing.* • See also SOCIAL SCIENCE list: *Communicating, Displaying Data.* • See also LANGUAGE ARTS list.
Generalizing/Applying Process to New Problems	• Using knowledge acquired about animals to work on Nature Trails. • Using knowledge acquired to care for other animals or pets. • See also SOCIAL SCIENCE list: *Generalizing/Applying Process to Daily Life.*

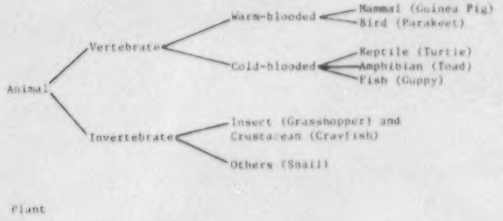
Areas of Study

Measurement	• Measuring length with tape measures, meter sticks, or rulers. • Measuring weight of animal or food with a scale of balance. • Measuring temperature of cages with thermometers. • Using stopwatches to time an animal's running or crawling. • See also MATHEMATICS list: *Measuring*.
Motion	
Speed/Velocity	• Timing animals over a specified distance to determine their rate of movement.
Force	• Observing that force must be used to push a handsaw or hammer nails into wood for cages. • Observing that saber saws are faster and require less effort to cut Tri-Wall or lumber than handsaws. • Observing that some animals can push, pull, or lift objects.
Friction	• Observing that, as a piece of wood is sanded, it becomes smoother and offers less resistance to the motion of the sandpaper. • Observing that a blade becomes warmer when a piece of wood is sawed vigorously because doing work against the force of friction generates heat.
Air Pressure	• Observing that water in an animal's bottle does not run out the end of the tube because it is held in by the pressure of the air around it. • Observing that siphons must be filled completely with water in order for them to work. Air can exert pressure to move liquids from one height to a lower height.
Weight	• Observing that weight is a measure of gravity while weighing animals to compare them with others or to see how much they have grown. • Observing that birds and insects such as butterflies overcome the force of gravity through the use of their wings.

Mechanical Work and Energy	• Observing that animals and people both use energy when they move around. • Observing that electrical energy is transformed into mechanical energy when power tools are used. • See also FORCE.
Solids, Liquids, and Gases	
States of Matter	• Observing that water vapor condenses into water droplets on the inside of terraria, aquaria, and jars containing insects. • Observing that water must be added periodically to fish tanks because it evaporates into the air.
Properties of Matter	• Observing that materials used in cage construction have different properties; gerbils can chew through Tri-Wall but not wire, wood, or glass. • Observing that paper materials available for posters and flyers have different colors and different weights.
Heat/Temperature	• Observing changes in temperature in animals' containers by recording the height of mercury in a thermometer. • Noting that animals' bodies give off heat, which is a product of the process of assimilating food into the body. • Observing that a heating pad can warm the bottom of animals' containers by changing electrical energy to heat energy.
Light	• Observing that animals are of different colors, caused by the reflection of light of a given color and the absorption of light of other colors by the pigment in the animal. • Observing that some animals respond to various colors while others do not. Animals have different abilities to see colors.
Sound	• Observing that sounds made by animals differ in pitch, tone, loudness, and quality. • Observing that animals respond to sounds in different ways.

Animal and Plant Classification

- Observing that each type of animal has different physical characteristics which distinguish them from other types of animals. A scientific system of classification has been devised for all living things based on physical differences and similarities.



- Observing that plants used as foods for animals may also be classified by physical characteristics.

Ecology/Environment

- Noting that an animal's comfort depends on the kind of home it has and the care it receives.
- Observing that animals captured outside and kept in the zoo are healthiest and happiest when their living environment is as much like their natural habitat as possible.
- Observing that animals kept in terraria are dependent on plants for food and/or shelter.

Nutrition/Growth

- Observing that feeding animals regularly is critical to their survival.
- Noting that animals eat plants or other animals or sometimes both.
- Observing growth in young animals by weighing or measuring them and keeping growth records.

Genetics/Heredity/Propagation

- Observing that baby animals born in the zoo closely resemble their parents.
- Noticing that baby animals may resemble one parent more than another because one genetic characteristic may dominate another.
- Observing that not all babies in the same litter look exactly alike because no two animals have exactly the same genetic makeup.

Animal and Plant Behavior	• Observing that animals move around and respond to different stimuli. • Observing emotional responses in animals: affection, dependence, aggression, fear, etc. • Observing learning in animals, e.g., development of feeding and grooming habits in young ones that are weaned. • Observing that animals vary in their behavior according to their type; e.g., mammals engage in a wider variety of activities than insects. • Noting that animals vary in behavior according to the individual; e.g., one guinea pig may prefer lettuce while another may prefer carrots. • Observing the importance of variety in the life of caged rodents; e.g., most rodents like human attention, variations in their diet, and some form of exercise (e.g., exercise wheel, being let out of cage).
Anatomy/Physiology	• Noting differences in animals based on internal and external structure.

ACTIVITIES IN SCHOOL ZOO UTILIZING SOCIAL SCIENCE

Process

Observing/Describing/Classifying	• Observing and classifying effects on students of handling, caring for, and learning about animals. • Observing students' emotional responses to animals. • Observing that most people enjoy animals and like handling many of them. • Categorizing types of information that can be presented to other students. • See also MATHEMATICS list: *Classifying, Categorizing.* • See also SCIENCE list: *Observing/Describing; Classifying.*
Identifying Problems, Variables	• Identifying different attitudes students have towards animals. • Identifying behavior towards animals in the zoo, e.g., carelessness or cruelty, that needs to be changed to improve the welfare of the animals. • Identifying age and previous experience as important factors in the way people respond to animals. • Identifying tours, displays, etc., as factors that could be changed to increase interest in the zoo. • See also SCIENCE list: *Identifying Variables.*
Manipulating, Controlling Variables/ Experimenting	• Deciding that certain behavior (e.g., cruelty) towards animals should not be allowed. • Experimenting with different ways of advertising the zoo and showing it to other people. • See also SCIENCE list: *Manipulating, Controlling Variables/Experimenting.*
Inferring/Predicting/Formulating, Testing Hypotheses	• Inferring that caring for animals makes students more understanding and sympathetic toward them. • Inferring that certain animals in the zoo are like people in some ways, and are not like people in others. • Hypothesizing that a certain type of display will increase interest in zoo; testing hypothesis by counting numbers of requests for tours. • See also SCIENCE list: *Inferring/Predicting/Formulating, Testing Hypotheses.*

Collecting, Recording Data/ Measuring	• Using voting procedure to decide on animals for the zoo, ways of raising money, etc. • Counting number of people who visit the zoo. • See also MATHEMATICS list: *Counting/Measuring.* • See also SCIENCE list: *Measuring/Collecting, Recording Data.*
Organizing, Processing Data	• Tallying votes when making decisions about the zoo. • Tallying number of visitors to the zoo. • See also MATHEMATICS list: *Organizing Data.* • See also SCIENCE list: *Organizing, Processing Data.*
Analyzing, Interpreting Data	• Comparing qualitative information gathered from interviews with zoologists, pet store owners, etc. • Making a decision based on results of a class vote. • Comparing numbers of people taking tours before and after displays are changed. • See also SCIENCE list: *Analyzing, Interpreting Data.*
Communicating, Displaying Data	• Making charts or graphs on number of people visiting the school zoo. • See MATHEMATICS list: *Graphing.* • See SCIENCE list: *Communicating, Displaying Data.* • See LANGUAGE ARTS list.
Generalizing/Applying Process to Daily Life	• Using knowledge acquired from teaching students about animals to teach people other things. • Using knowledge acquired about animals to improve personal behavior and behavior of other people toward animals and their environments. • Using knowledge acquired from observing animal behavior for understanding human social systems; comparing similarities and differences between the two. • See also SCIENCE list: *Generalizing/Applying Process to New Problems.*
Attitudes/Values	
Accepting Responsibility for Actions and Results	• Making sure that various tasks (e.g., making cages, feeding, cleaning cages) are done. • Scheduling times for an open house. • Being responsible for the welfare of the animals in the zoo.

Developing Interest and Involvement in Human Affairs	• Making a school zoo for other children to enjoy.
Recognizing the Importance of Individual and Group Contributions to Society	• Recognizing that the zoo will benefit not only themselves but other children in the school. • Recognizing that opening the zoo to the school may make other people more understanding of animals.
Developing Inquisitiveness, Self-Reliance, and Initiative	• Conducting small and large group sessions with help from the teacher. • Finding solutions to problems encountered in addition to the main problem of the challenge. • Using the telephone to find information or to get in touch with experts on animals. • Choosing and developing the best way to show the zoo to other people.
Recognizing the Values of Cooperation, Group Work, and Division of Labor	• Finding that work on the zoo progresses more rapidly and smoothly when done in groups. • Eliminating needless overlap in work. • Finding that work is fun when people cooperate.
Understanding Modes of Inquiry Used in the Sciences; Appreciating Their Power and Precision	• Using scientific modes of inquiry to investigate animal behavior and solve problems when making the zoo. • Using data, graphs, drawings, and written materials to explain the zoo and the animals to people. • See also MATHEMATICS and SCIENCE lists.
Respecting the Views, Thoughts, and Feelings of Others	• Considering all suggestions and assessing their merits. • Considering the opinions of others, such as other classes or maintenance personnel, when maintaining a zoo. • Recognizing and respecting differences in values according to age, experience, occupation, income, interests, culture, race, religion, ethnic background. • Respecting the thoughts, interests, and feelings of members of the opposite sex when working in groups. • Recognizing and respecting feelings of animals in the zoo.
Being Open to New Ideas and Information	• Considering alternative ways of doing various tasks. • Conducting library research on animals and their care. • Asking other people for opinions, ideas, and information.

Learning the Importance and Influence of Values in Decision Making	• Learning that cost and space are not the only factors to consider when making a zoo; animals' comfort and the way the zoo affects other people (other classes, janitors) must be considered.
Areas of Study	
Anthropology	• Observing and describing responses to animals related to cultural and geographic background.
Economics	• Gaining experience in comparative shopping for animals, animal food, and materials for making animal homes.
Geography/Physical Environment	• Investigating differences in animals due to differences in geography of their native habitats.
Political Science/Government Systems	• Investigating state laws concerning captivity of wild animals and the use of animals in classrooms. • Determining need for rules when caring for animals and opening the zoo to the public.
Recent Local History	• Investigating previous attempts to establish a zoo in the school.
Social Psychology/Individual and Group Behavior	• Developing a gimmick for advertising the school zoo. • Recognizing need for leadership within small and large groups; r cognizing differing capacities of individuals for various roles within groups. • Analyzing the effects of a small group making decisions for a larger group.
Sociology/Social Systems	• Considering the integral, related nature of the school community when making a school zoo. • Devising a system of working cooperatively in small and large groups. • Working within established social systems to develop a school zoo.

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Sociology/Social Systems (cont.)	• Experiencing and understanding differences in social systems in different social groups (children, adults, women, men, homemakers.) • Recognizing that there are many different social groups and that one person belongs to more than one social group.

ACTIVITIES IN SCHOOL ZOO UTILIZING LANGUAGE ARTS

Basic Skills

Reading: Literal Comprehension--Decoding Words, Sentences, and Paragraphs	• Decoding words, sentences, and paragraphs while reading books on animals or pet care; while reading directions on animal food packages.
Reading: Critical Reading—Comprehending Meanings, Interpretation	• Obtaining factual information about animals and their care. • Understanding what is read about animals. • Interpreting what is read, such as biology and physiology concepts.
Oral Language: Speaking	• Offering ideas, suggestions, and criticisms during discussions in small group work and during class discussions on animal care and on building a zoo. • Reporting to class about animal care, data collecting, cage construction, etc. • Responding to criticisms of activities. • Preparing, practicing, and giving effective oral presentation to classes or other people visiting the zoo. • Using the telephone properly and effectively to obtain information or to invite a resource person to speak to the class. • Using rules of grammar in speaking.
Oral Language: Listening	• Conducting interviews of classmates, pet store owners, etc. • Following spoken directions. • Listening to group reports.
Oral Language: Memorizing	• Memorizing portions of oral presentations to be given during tours of the zoo.
Oral Language: Spelling	• Using correct spelling in writing.
Written Language: Grammar	• Using rules of grammar in writing.

Written Language: Composition	• Writing to communicate effectively:
	  • preparing written reports and pamphlets using notes, data, charts, graphs, drawings, etc., explaining the animals' habits, genetic background, etc.
	  • writing posters advertising the zoo.
	  • preparing write-ups of rules to follow while visiting the zoo.

Study Skills: Outlining/Organizing	• Taking notes when consulting authorities or books about animals. • Planning presentations, experiments, etc. • Organizing ideas, facts, data for inclusion in pamphlets about animals.
Study Skills: Use of References and Resources	• Using the library to research information on animals. • Using dictionary and encyclopedia to locate information. • Inviting a zoologist or other expert to speak to the class and answer questions. • Using indexes and tables of contents of books to locate desired information. • Using "How To" Cards for information on making animal homes, etc.
Attitudes/Values	
Appreciating the Value of Expressing Ideas Through Speaking and Writing	• Finding that classmates and teacher may approve of an idea if it is presented clearly. • Finding that other students may appreciate the zoo if it is explained clearly and with enthusiasm.
Appreciating the Value of Written Resources	• Finding that certain desired information can be found in books on animals, e.g., identification of amphibians, reptiles, or insects.
Developing an Interest in Reading and Writing	• Willingly looking up information on animals and pet care. • Looking up further or more detailed information. • Showing desire to work on drafting pamphlets.

Making Judgments Concerning What is Read	• Deciding whether what is read is applicable to the particular animal. • Deciding how reliable the information obtained from reading is. • Deciding whether the written material is appropriate, whether it says what it is supposed to say, whether it may need improvement.
Appreciating the Value of Different Forms of Writing, Different Forms of Communication	• Finding that how information can be best conveyed is determined in part by the audience to whom it is directed. • Finding that certain data or information can be best conveyed by writing it down, making sketches, drawing graphs or charts, etc. • Finding that information on animals and care can be most easily shared by speaking. • Finding that certain data or information should be written down so that it can be referred to at a later time. • Finding that spoken instructions are sometimes better than written instructions, and vice versa.